

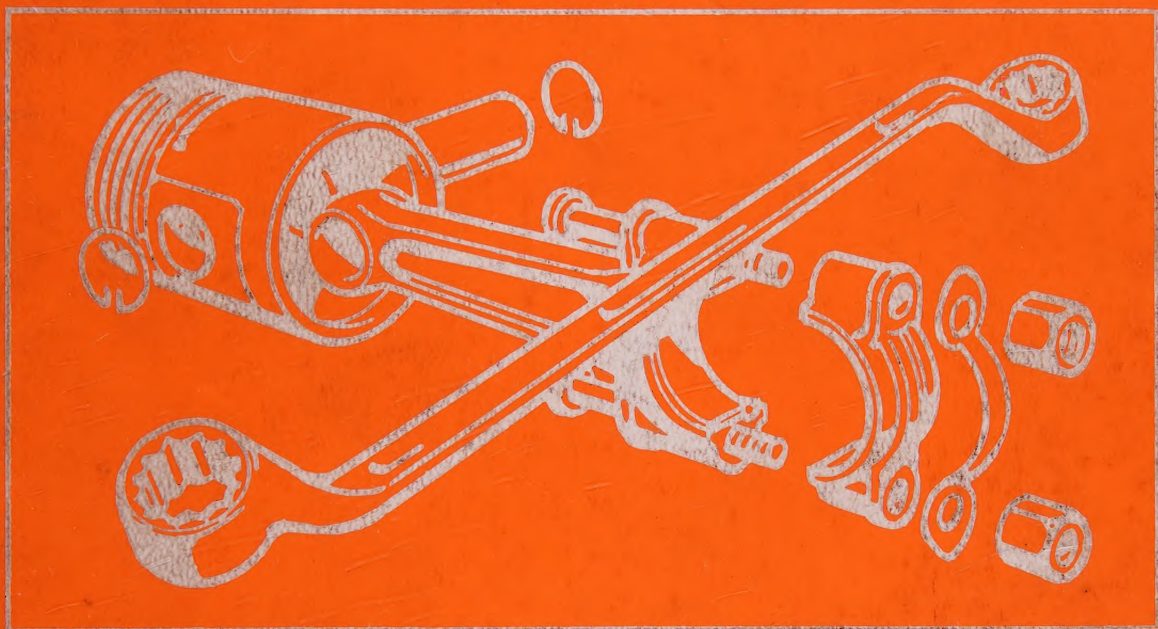


Workshop Manual
for SPITFIRE 1, 2, 3
GT6 1962 on

and the



VITESSE 1600
2 litre 1966 on



TRIUMPH SPITFIRE, VITESSE, 1962-69 AUTOBOOK

Philip H. Smith

AUTOPRESS LTD

(RS)

11. APR. 1973

-9 JAN. 1976

31. DEC. 1975

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TRIUMPH SPITFIRE, VITESSE 1962-69 AUTOBOOK

Workshop Manual for the Spitfire Mk. 1, 2 and 3,
Vitesse 1600 2 litre and GT6 1962 on

by

Philip H. Smith

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First Edition May 1969
Second Edition January 1970

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Printed in England by
G. Beard & Son
Brighton

ACKNOWLEDGEMENT

Almost from the introduction of the original Triumph Herald, the author has owned cars of this basic layout, advantage having been taken of the availability of more powerful engines as introduced, up to and including the Vitesse Two-litre. Over this considerable period of ownership, he has had the most complete co-operation from the manufacturers when producing articles and books dealing with the more general aspects of design and maintenance.

This co-operation has continued in the case of the present volume, and full acknowledgement is extended to Standard-Triumph Limited for their loan of original photographs and permission to reproduce these and other illustrative matter.

Ilkley
Yorkshire

P.H.S.

INTRODUCTION

This do-it-yourself Workshop Manual has been specially written for the owner who wishes to maintain his car in first class condition and to carry out his own servicing and repairs. Considerable savings on garage charges can be made, and one can drive in safety and confidence knowing the work has been done properly.

Comprehensive step-by-step instructions and illustrations are given on all dismantling, overhauling and assembling operations. Certain assemblies require the use of expensive special tools, the purchase of which would be unjustified. In these cases information is included but the reader is recommended to hand the unit to the agent for attention.

The high-performance saloon, convertible and sports-type cars dealt with in this book are based on a fully-proved and established Triumph design incorporating a girder-frame backbone chassis with wishbone-linkage independent front suspension and a rear suspension system also independent, making use of swinging half axle shafts in conjunction with a transverse leaf-spring and appropriate linkages. The engines are of conventional in-line type, but have been developed for use with high-octane fuels, in such matters as compression ratio, combustion chamber shape, manifold design and carburation arrangements. Thus, the performance obtainable from the standard car is sufficient for most users. However, the straightforwardness of the pushrod ohv engine makes it very suitable for modification and tuning to produce extra power, and for this purpose, conversion equipment is available from established Triumph competition specialists.

Throughout the Manual hints and tips are included which will be found invaluable and there is an easy to follow fault diagnosis at the end of each chapter. Under no conditions should attempts be made to substitute 'blacksmith' methods for the use of special Triumph agents' equipment, as serious and expensive damage may result.

In view of the specialized information now available (based on practical experience) of various modifications, no attempt has been made here to give advice on altering performance in any way from standard. Nevertheless the book will be found invaluable in enabling extensive dismantling operations to be tackled, and the necessary inspection and rectification to be carried out prior to such modifications.

It cannot be too strongly emphasized that before 'adding power' the owner should satisfy himself that his car in standard form is already giving of its best; this implies meticulous attention to all details of operation, as described in this book. For further reading, in the context of both good road performance as standard, and the improvement likely to accrue from the alterations which can be carried out using marketed components, the author feels justified in drawing attention to two of his other books: 'Tuning for Speed and Tuning for Economy' and 'Car Performance and the Choice of Conversion Equipment'. Whilst every care has been taken to ensure correctness of information, it is obviously not possible to guarantee complete freedom from errors, nor to accept liabilities arising out of such errors or omissions. These apart, it should also be noted that manufacturers' practice nowadays is to carry out minor design changes and improvements as experience dictates, without interruption of production runs, when such matters do not involve basic alterations to design.

CHAPTER 1

THE ENGINE

1:1 Engine construction	1:10 Flywheel	1:18 Pistons and rings
1:2 Six-cylinder engines	1:11 Oil pump removal	1:19 Chain cover assembly
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1:5 The manifold system	1:14 Valve removal	1:22 Head replacement
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1:7 Cylinder bores	1:16 Crankshaft replacement	1:24 Manifolds
1:8 Bearings	1:17 Camshaft and drive	1:25 Fault diagnosis
1:9 Pistons		

The Triumph cars covered by this book are based on the backbone chassis with transverse-leaf independent swing-axle rear suspension, which was first introduced with the 948 cc 'Herald' saloon. A similar construction has been

used subsequently for a range of cars up to 2 litres engine volume. A similar basic engine design having common piston stroke dimension is used throughout, with four or six in-line cylinders. Details of the range are as follows:

Type of car	'Spitfire' Mk. I	'Spitfire' Mk. II	'Spitfire' Mk. III	'Vitesse' 1.6-litre	'Vitesse' 2-litre	G.T.6 2-litre
Number of cylinders	4	4	4	6	6	6
Cylinder bore (mm)	69.3	69.3	73.7	66.75	75	75
Piston stroke (mm)	76	76	76	76	76	76
Swept volume (cm ³)	1147	1147	1296	1596	1998	1998
Compression ratio	9.0:1	9.0:1	9.0:1	8.75:1	9.5:1	9.5:1
Maximum bhp/rev/min	63	67	75	70	95	95
Maximum torque (lb/ft) at rev/min	5750	6000	6000	5000	5000	5000
Maximum torque (lb/ft) at rev/min	67	67	75	92.5	115	115
Maximum bmp (lb/sq in) at rev/min	3500	3750	4000	2800	3000	3000
Maximum bmp (lb/sq in) at rev/min	144	144	144	143	142	142
No. of carburettors and type	3500	3750	4000	2800	3000	3000
	2	2	2	2	2	2
	SU	SU	SU	Solex	Stromberg	Stromberg

NOTE: 'Vitesse' 1.6-litre. Later cars are fitted with two Stromberg carburettors.

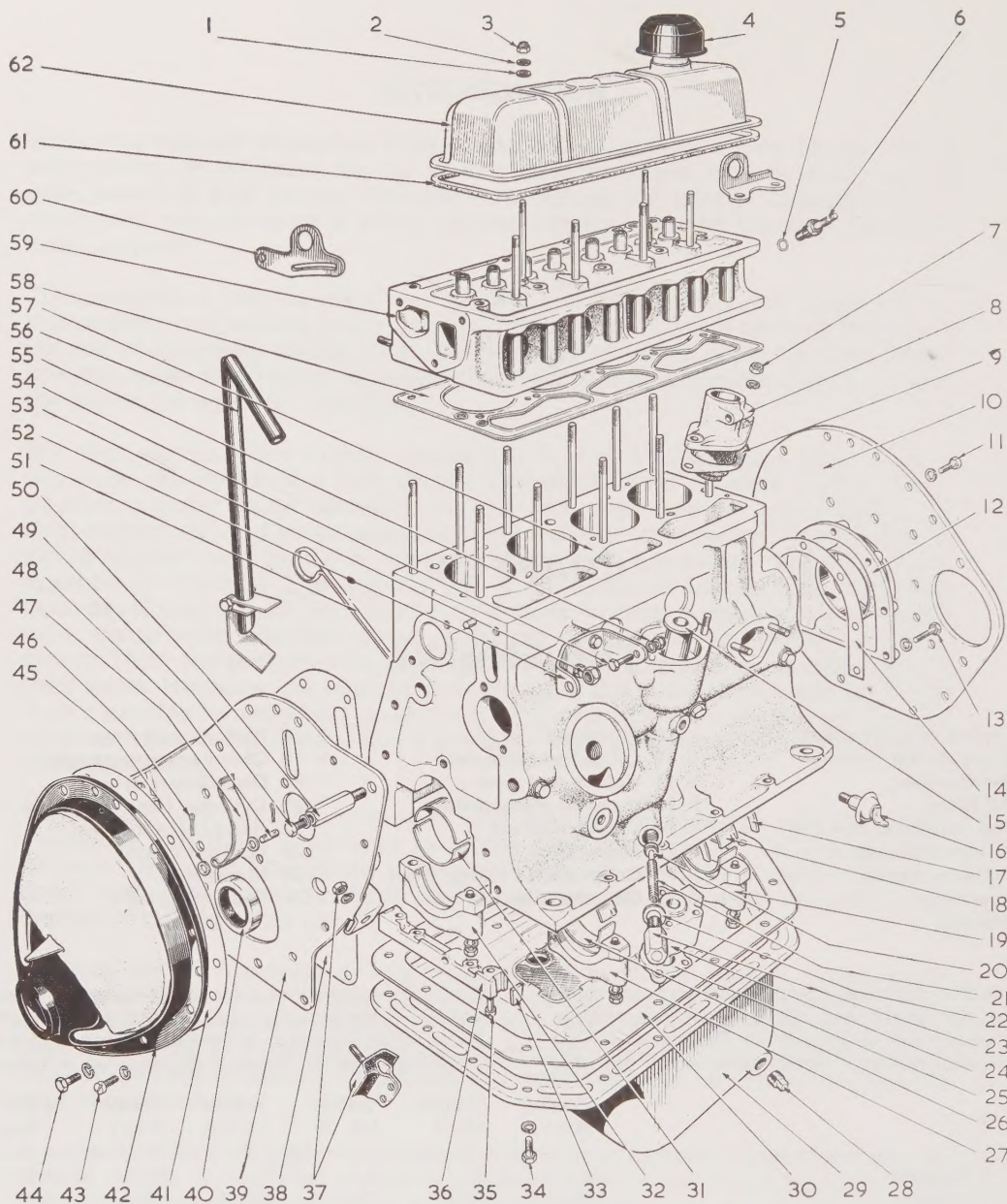


Fig 1:1 Main fixed components of 4-cylinder engine.

Key to Fig 1:1 1 Fibre washer. 2 Plain washer. 3 Nyloc nut. 4 Filler cap. 5 Copper/asbestos washer. 6 Sparking plug.
 7 Nut. 8 Adaptor. 9 Gasket. 10 Rear engine plate. 11 Bolt. 12 Rear oil seal. 13 Bolt. 14 Gasket. 15 Oil pump drive shaft bush.
 16 Oil pressure switch. 17 Crankshaft thrust washer. 18 Rear bearing shell. 19 Rear bearing cap. 20 Relief valve. 21 Spring.
 22 Copper washer. 23 Cap nut. 24 Oil pump body. 25 Oil pump end plate. 26 Centre bearing shell.
 27 Centre main bearing cap. 28 Sump plug. 29 Sump. 30 Sump gasket. 31 Front bearing shell. 32 Front main bearing cap.
 33 Sealing wedges. 34 Sump bolt. 35 Slotted screw. 36 Front sealing block. 37 Front engine mounting. 38 Gasket.
 39 Front engine plate. 40 Oil seal. 41 Gasket. 42 Front timing cover. 43 Slotted setscrew. 44 Bolt. 45 Plain washer.
 46 Split pin. 47 Chain tensioner. 48 Pivot pin. 49 Bolt. 50 Generator pedestal. 51 Dipstick. 52 Bracket. 53 Nyloc nut.
 54 Bolt. 55 Nyloc nut. 56 Breather pipe. 57 Cylinder block. 58 Cylinder head gasket. 59 Cylinder head.
 60 Generator adjusting link. 61 Rocker cover gasket. 62 Rocker cover.

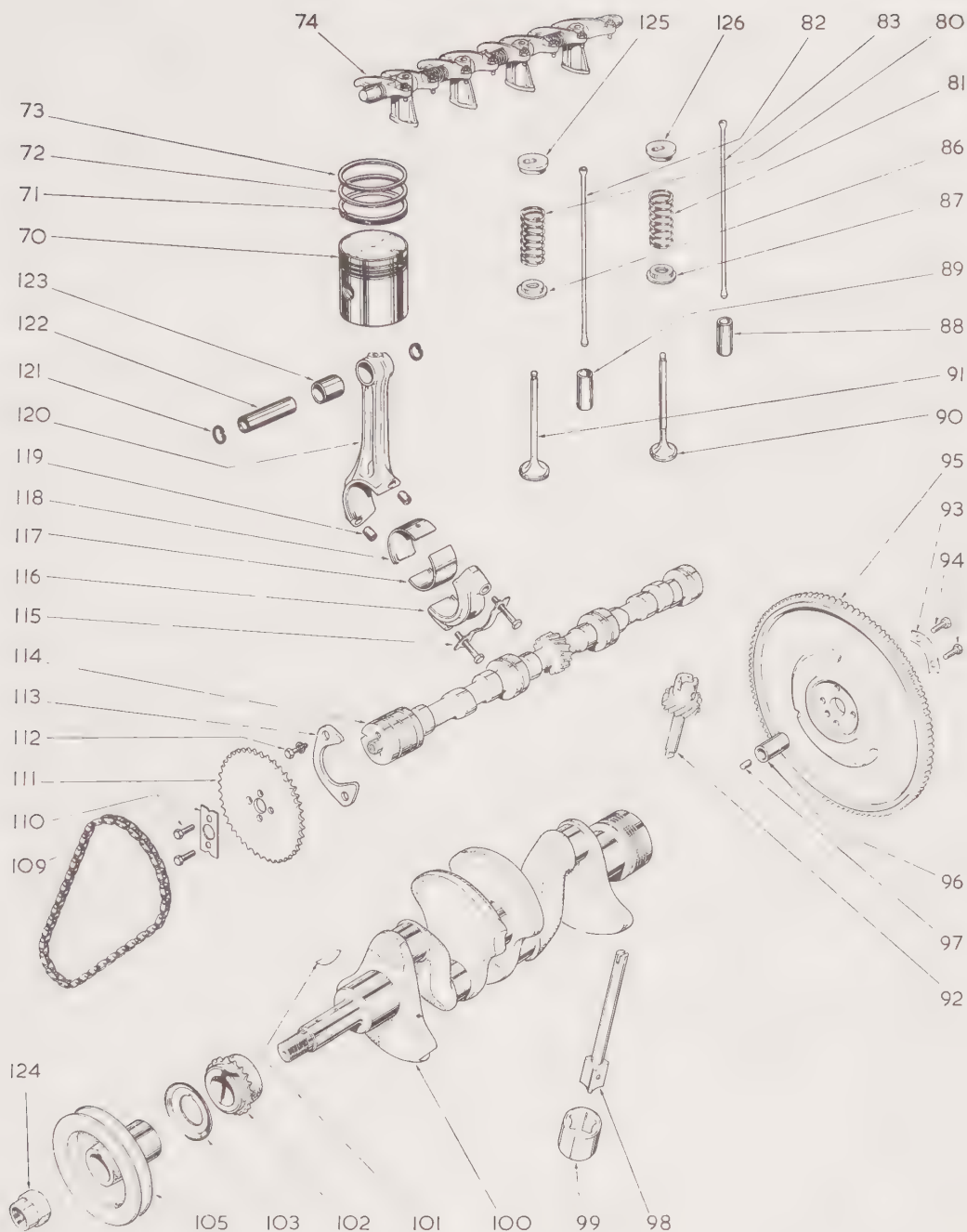


Fig 1:2 Main moving components of 4-cylinder engine.

Key to Fig 1:2 70 Piston. 71 Oil control ring. 72 Taper compression ring. 73 Plain compression ring. 74 Rocker assembly. 80 Spring—outer. 81 Spring—outer. 82 Push-rod. 83 Push-rod. 86 Lower collar. 87 Lower collar. 88 Tappet. 89 Tappet. 90 Exhaust valve. 91 Inlet valve. 92 Distributor and oil pump drive gear. 93 Lock tab. 94 Bolt. 95 Flywheel. 96 Bush. 97 Dowel. 98 Inner rotor and spindle. 99 Outer rotor. 100 Crankshaft. 101 Key. 102 Sprocket. 103 Flinger. 104 Crankshaft pulley. 105 Timing chain. 106 Bolts and lock tab. 107 Camshaft sprocket. 108 Bolt. 109 Keeper plate. 110 Camshaft. 111 Bolt and locktab. 112 Conn-rod cap. 113 Conn-rod bearing shell—lower. 114 Conn-rod bearing shell—upper. 115 Dowels. 116 Conn-rod. 117 Circlip. 118 Gudgeon pin. 119 Gudgeon pin bush. 120 Nut. 121 Collet. 122 Collet.

The four-cylinder 'Spitfire' engine shown in **FIGS 1:1** and **1:2** has push-rod operated overhead valves, arranged vertically in one row in the cast-iron cylinder head; there is an exhaust valve at each end of the head, and an adjacent pair at the centre, the inlet valves being in two pairs between the exhaust valves. Separate exhaust ports are provided. The 1147 cc engines have two siamesed inlet ports at the flange face, each serving a pair of inlet valves. Four separate inlet ports are provided on 1296 cc engines.

1:1 Engine construction

The cylinder block is combined with the crankcase in a robust iron casting, the sump flange being well below the main bearing centre line. Three main bearings for the forged steel counterbalanced crankshaft are carried on substantial webs, the bearings being of the steel-backed thinwall type, with linings appropriate to the duty as stated in the Appendix. Crankshaft thrust and end-float are controlled by half washers located on each side of the rearmost bearing. The connecting-rod big-end bearings are also of steel-backed thinwall type and are split diagonally to allow of withdrawal upwards through the cylinder bore. The connecting-rods are of H-section steel, with a pressed-in small end-bush, reamed after fitting. The pistons are of aluminium alloy with a split skirt, and the gudgeon pin bosses are offset to reduce piston noise. Two compression and one oil-control ring are fitted, all located above the gudgeon pin. The latter is a push-fit in the piston bosses and is retained by circlips except in the case of some engines, on which the gudgeon pins are an interference fit in the connecting-rod small-end eye, requiring a pressure of approximately 1120 lb to force the pin into the eye.

The camshaft runs in four bearings which are bored directly in the block casting. Between the two intermediate bearing journals, a skew gear is cut on the shaft, to drive the oil pump and distributor. The camshaft drive comprises a single-strand precision roller chain, the driving sprocket being carried on the front end of the crankshaft behind the belt pulley. To reduce chain flap, a spring-blade tensioner is mounted inside the pressed-steel chain cover, and is arranged to bear on the non-driving side of the chain.

The barrel-type tappets reciprocate directly in bores machined in the main casting, and are shaped at their inner ends to receive the lower ends of the solid steel push-rods. The valve rockers are mounted on a hollow rocker-shaft which is supported on detachable pedestals carried on head studs. The rocker bushes are pressure-fed with lubricant from the hollow shaft, the spillage also lubricating the valve-stems and push-rod ends.

The oil-pump is of eccentric bi-rotor type, mounted in the base chamber and driven from a vertically-disposed shaft having a skew gear to mesh with the camshaft gear. The oil is drawn from the sump by way of a vertical intake pipe, the delivery being to the annular space around the pump drive shaft, thence to a long gallery cast in the crankcase on the engine near-side. The flow from the pump annulus is ducted in its entirety to a full-flow canister-type filter mounted externally on the oil gallery. From this filter the oil then passes to the gallery. From the gallery the oil is ducted through various passages and drillings to the main and camshaft bearings. The big-ends are supplied through crankshaft drillings in the normal

manner, the oil-fling from the big-ends taking care of the cylinder bores and gudgeon pin.

The rearmost camshaft bearing has a pair of flats on its diameter which, in conjunction with a vertical drilled passage at the rear of the block, serve to supply an intermittent measured feed to the overhead rocker-shaft. The camshaft drive is lubricated by oil spillage from the front camshaft bearing. Maximum oil pressure is controlled by a spring-loaded release valve housed under a domed nut on the crankcase nearside above the pump. There is a pressure switch screwed into the gallery at about its centre, which operates a dashboard warning light at low pressure, the switch contacts closing in these circumstances.

1:2 Six-cylinder engines

The six-cylinder engine shown on **FIGS 1:3** and **1:4** has four main crankshaft bearings, and five camshaft bearings, the skew gear for the oil pump and distributor drive being located between the second and third bearings from the rear. The cylinder head is provided with six separate ports for the inlet valves and similarly for the exhausts. In other respects the construction does not differ significantly from the four-cylinder unit already described. Individual details for all engines are given in the Appendix.

1:3 Overhauling

The information which follows concerning dismantling and overhauling procedure will apply regardless of the purpose of such work, which may range from simple decarbonizing to complete renovation. Where special tuning and modification is required involving, for example, substitution of components, the applicable sequence will also apply. It is possible to carry out quite extensive dismantling without removing the engine from the car, so long as a pit or ramp is available to provide room for underneath working. However, for the probable majority who prefer to work in professional style at the bench, it will be useful to give brief details of the procedure for engine removal. This may vary a little according to the type of car and coachwork, but the main requirements are covered by what follows, while further particulars regarding individual items will be found in the chapters relating to these.

To remove the engine and gearbox in one unit, the water and oil should first be drained off, and the battery disconnected and lifted out. Next remove the bonnet. Disconnect the main fuel pipe from the petrol pump inlet, and plug its end to prevent siphoning. Uncouple all carburettor controls, the cable from the starter motor terminal, and the bracket and flange holding the exhaust pipe to the clutch housing. Take off all the water hoses, and remove the radiator, as detailed in Chapter 4. Remove the electric wiring from the generator, ignition coil, and oil pressure switch, also the earthing strap, fan assembly and petrol pipe. Disconnect the tachometer drive cable.

Next, working inside the car, take out the front seats and carpets and remove the cover over the gearbox housing (**FIG 1:5**). Uncouple the speedometer cable. Remove the clutch slave (operating) cylinder, and ensure that it is clear of the gearbox (see Chapter 5). Disconnect the front end of the propeller shaft at the flange as described in Chapter 6, also the electric cables to the overdrive solenoid if fitted. Remove the gearbox extension, and put a suitable cover over the aperture in the gearbox to ensure exclusion of dirt.

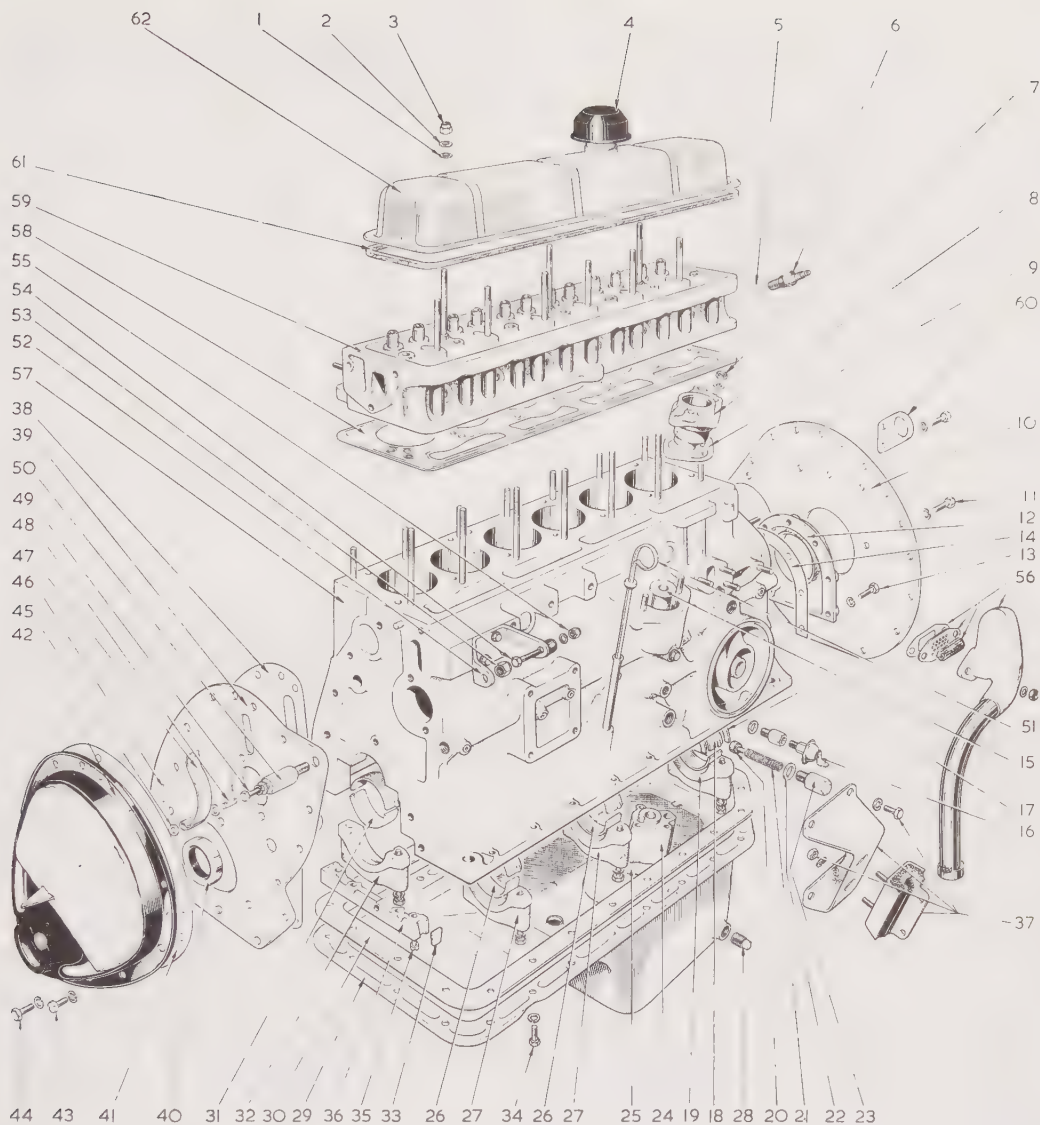


Fig 1:3 Main fixed components of 6-cylinder engine.

Key to Fig 1:3 1 Fibre washer. 2 Plain washer. 3 Nyloc nut. 4 Filler cap. 5 Copper/asbestos washer. 6 Sparking plug
 7 Nut. 8 Adaptor. 9 Gasket. 10 Rear engine plate. 11 Bolt. 12 Rear oil seal. 13 Bolt. 14 Gasket.
 15 Oil pump drive shaft bush. 16 Oil pressure switch. 17 Crankshaft thrust washer. 18 Rear bearing shell. 19 Rear bearing cap
 20 Relief valve. 21 Spring. 22 Copper washer. 23 Cap nut. 24 Oil pump body. 25 Oil pump end plate. 26 Centre bearing shell
 27 Centre main bearing cap. 28 Sump plug. 29 Sump. 30 Sump gasket. 31 Front bearing shell. 32 Front main bearing cap
 33 Sealing wedges. 34 Sump bolt. 35 Slotted screw. 36 Front sealing block. 37 Front engine mounting. 38 Gasket
 39 Front engine plate. 40 Oil seal. 41 Gasket. 42 Front timing cover. 43 Slotted setscrew. 44 Bolt. 45 Plain washer
 46 Split-pin. 47 Chain tensioner. 48 Pivot pin. 49 Bolt. 50 Generator pedestal. 51 Dipstick. 52 Bracket. 53 Nyloc nut.
 54 Bolt. 55 Nyloc nut. 56 Breather pipe. 57 Cylinder block. 58 Cylinder head gasket. 59 Cylinder head.
 60 Generator adjusting link. 61 Rocker cover gasket. 62 Rocker cover.

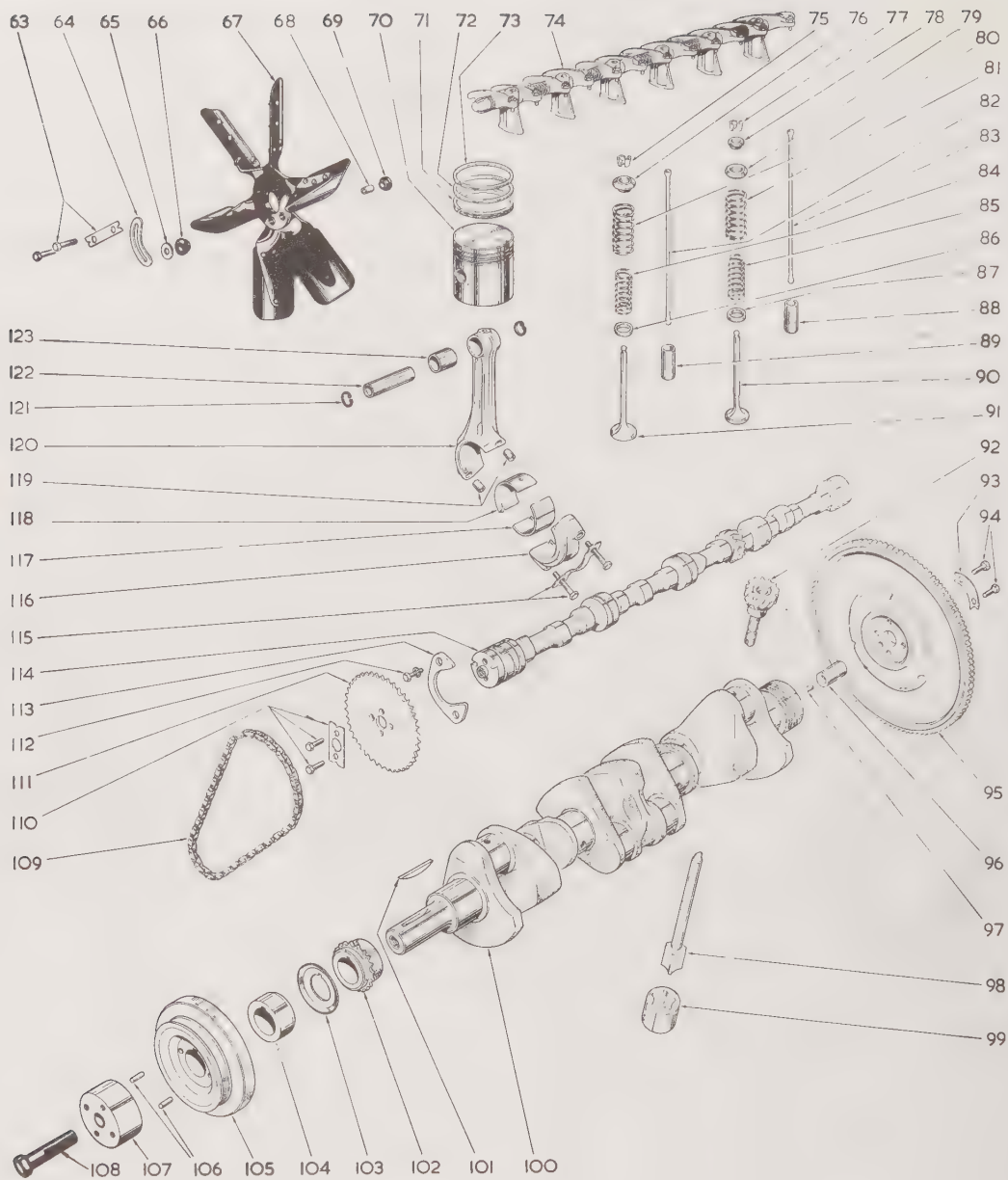


Fig 1:4 Main moving components of 6-cylinder engine.

Key to Fig 1:4 63 Bolts and lock tabs. 64 Balancer. 65 Washer. 66 Rubber bush. 67 Fan assembly. 68 Steel bush. 69 Rubber bush. 70 Piston. 71 Oil control ring. 72 Taper compression ring. 73 Plain compression ring. 74 Rocker assembly. 75 Split cotters. 76 Collar. 77 Split cotters. 78 Inner collar (exhaust). 79 Outer collar (exhaust). 80 Spring—outer. 81 Spring—outer. 82 Push-rod. 83 Push-rod. 84 Spring—inner. 85 Spring—inner. 86 Lower collar. 87 Lower collar. 88 Tappet. 89 Tappet. 90 Exhaust valve. 91 Inlet valve. 92 Distributor and oil pump drive gear. 93 Lock tab. 94 Bolt. 95 Flywheel. 96 Bush. 97 Dowel. 98 Inner rotor and spindle. 99 Outer rotor. 100 Crankshaft. 101 Key. 102 Sprocket. 103 Flinger. 104 Distance piece. 105 Crankshaft pulley. 106 Dowels. 107 Fan boss. 108 Bolt. 109 Timing chain. 110 Bolts and lock tab. 111 Camshaft sprocket. 112 Bolt. 113 Keeper plate. 114 Camshaft. 115 Bolt and lock tab. 116 Conn-rod cap. 117 Conn-rod bearing shell—lower. 118 Conn-rod bearing shell—upper. 119 Dowels. 120 Conn-rod. 121 Circlip. 122 Gudgeon pin. 123 Gudgeon pin bush.

A sling or lifting cable should next be attached to the engine lifting eyes to take the weight. When this is supported satisfactorily the front and rear engine mountings can be released by taking out their nuts and bolts, the former being shown on **FIG 1:6**. The engine unit must then be carefully eased out of the car, noting that the sump must properly clear the chassis cross-member. When this is verified, continue the lift, at the same time moving the unit forwards until it is clear of the bulkhead, and so out of the vehicle (see **FIG 1:7**). If it is desired to remove the engine only, leaving the gearbox in the frame, it is necessary to block up the latter from underneath so that it will not be left hanging on its mountings. With the engine slung as before, the starter motor must be taken off, followed by the bolts from the bellhousing flange, shown on **FIG 1:8**. Before removing the lowermost bolts, make sure that everything is properly supported, and when finally parting the flange keep the two units level so that there is no strain on the gearbox input shaft. As the engine is eased forwards, the shaft should be pulled cleanly out of the clutch centre. The engine can then be lifted out as before. In next describing the various components of the engine, more specific details for dismantling will be given.

1:4 Oil filter

The oil filter on 'Spitfire' engines is of Purolator, AC-Delco, or Tecalemit make, enclosed in a sealed canister which is screwed into a machined boss on the crankcase side. This type of filter must be discarded completely at the specified intervals, and replaced by a new one; it is shown on **FIG 1:9**. There is a central threaded boss for attachment to the crankcase, and around the corresponding register on the latter is a circular face against which registers a packing washer on the filter body. It will be seen from **FIG 1:9** that the lubricant passes into the filter from the pump via holes located inside the circular face, and after passing through the filter element, it returns to the gallery. This filter is, as a unit, renewed at the required mileage.

In the case of six-cylinder engines, the filter canister can be taken apart to reveal the element, and the latter only is renewed when required. The filter is attached to the engine by a long centre bolt; when this is removed, the canister will be released and the element can be removed from the inside (see **FIG 1:10**). The construction is clearly shown on **FIG 1:11**. Crankcase ventilation on earlier

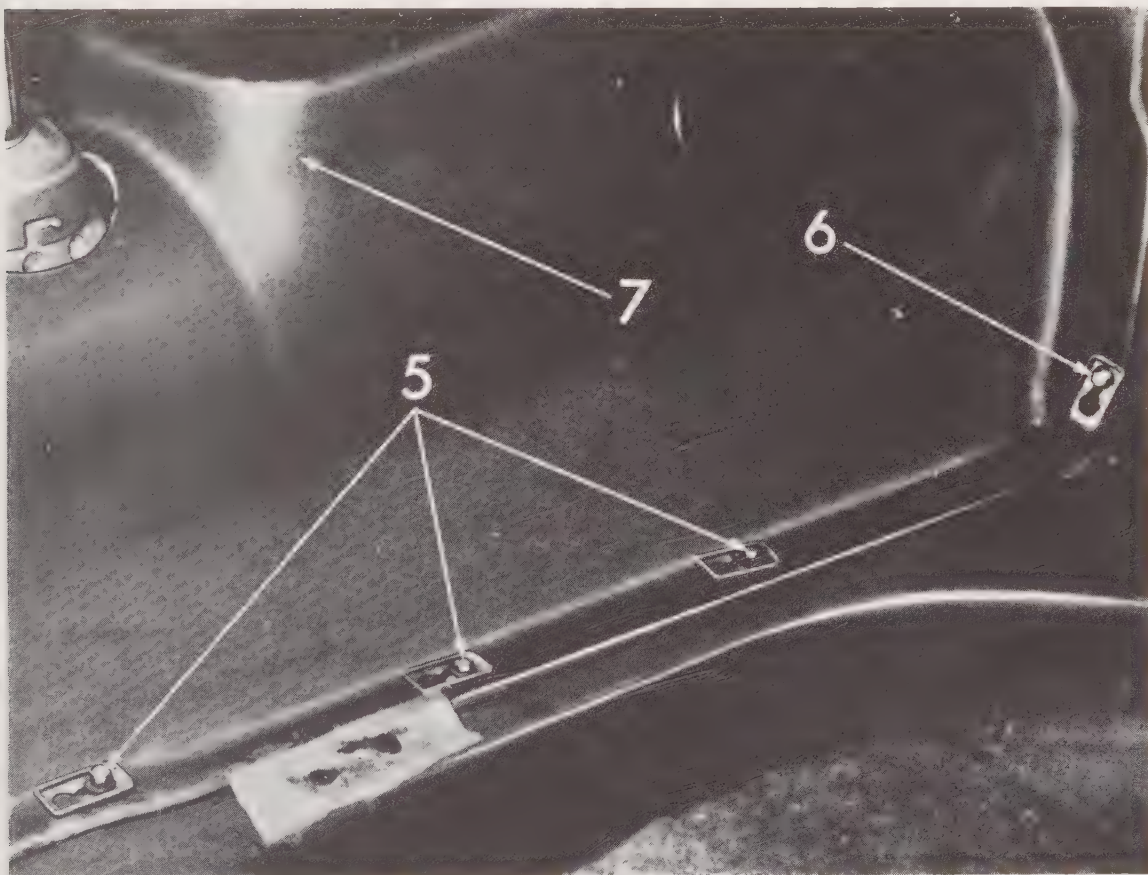


Fig 1:5 Gearbox cover and fixing points.

Key to Fig 1:5 7 Cover. 5 and 6 Fixing screws.

engines is by way of an open pipe attached to the push-rod cover. Later types have the rocker cover piped to the air filter to induce a partial vacuum in the crankcase, while the latest practice is to use a closed circuit system in which all crankcase fumes are consumed in the engine. This requires the addition of a one-way emission control valve, as described in Chapter 2, along with an oil filler cap having a suitably graded vacuum valve to regulate the flow of entering air.

1:5 The manifold system

The induction and exhaust manifolding varies according to engine type, but is fully clarified in **FIGS 1:12 to 1:15** inclusive. The manifold attachment to the cylinder head flange is by a number of studs, which are fitted with nuts and washers and clamping pieces. In all cases a one-piece gasket is employed. The exhaust manifold outlet is coupled to the downpipe by a flange with studs and nuts. The various types of carburettor are assembled to the manifolds as described in Chapter 2.

The integral cylinder block and crankcase has three or four main bearing webs according to the number of cylinders. For access to the crankcase, the sump must be removed by taking out the flange bolts. This will expose the oil-pump. These crankcase components however should not be dealt with until such items as the cylinder head and associated upper parts have been removed.

1:6 Bi-rotor oil pump

The pump comprises internally two rotors; the outer rotor turns in the circular body interior while the inner rotor is attached to the driving shaft. Its four lobes engage five internal segments on the outer rotor, so that when the shaft rotates the rotors gear into each other. At the same time the varying volume between the lobes and segments produces a pumping action at considerable pressure both positive and negative, so that the pump is inherently self-priming. The pump body is held to the crankcase register by three bolts which also retain the bottom end-cover to which the suction pipe is fixed. The components are detailed on **FIG 1:16**.

1:7 Cylinder bores

The cylinder bores are graded for size in production, and designated by letters F, G or H, according to dimensions. The symbol letter is stamped for identification on both the piston crown (**FIG 1:17**) and the side of the cylinder block adjacent to each bore. It is important that the grading is maintained whenever parts are replaced or renovation carried out. Dimensional details in respect of each grading will be found in the Appendix.

The valve push-rods are of solid steel, cupped at their top ends to receive the ball-ended rocker adjustment screws. When dismantled they should be checked for straightness both with a straight-edge and by rolling on a flat surface; bent rods must be replaced. The tappets are of chilled cast-iron and may be removed from above or below when the head or camshaft respectively have been taken off. The camshaft runs in plain bores, four and five journals being provided on four- and six-cylinder engines respectively. Axial thrust on the shaft due to the skew-gear auxiliary drive, is controlled by a thrust plate behind the chain-wheel, and secured to the crankcase wall by set-

screws. The camshaft drive chain has a pitch of 0.375 in and runs on sprockets having 21 and 42 teeth respectively; chain length is 62 pitches. There is a timing mark on each sprocket to indicate the correct relationship of crank and camshafts, as shown on **FIG 1:18**.

1:8 Bearings

The main bearing shells are supplied in various under-sizes for use when the shaft is reconditioned; standard dimensions are given in the Appendix. Also, to obtain the correct crankshaft end-float, various thicknesses of thrust washer can be obtained. The crankshaft rear oil seal comprises a close-fitting, bolted-on housing in conjunction with a large-diameter return scroll on the shaft, or a sealing ring located in the housing (**FIG 1:19**). At the front there is an oil thrower-disc just inside the timing chain cover and adjacent to the sprocket, and a sealing ring in the cover itself which locates snugly around the crankshaft boss when the latter is in position.

The H-section forged steel connecting-rods have their big-end caps attached by two fitted bolts secured by a locking plate. The big-end bearings are split diagonally, with the caps facing the camshaft side of the engine. The big-end bearing shells have a copper-lead lining with indium flashing. When the bearing caps are removed they must be marked with paint to ensure replacement in their original positions.

The bearing shells, both main and big-end, must also be replaced on their original journals and in the same relative positions as when removed, as shown on **FIG**

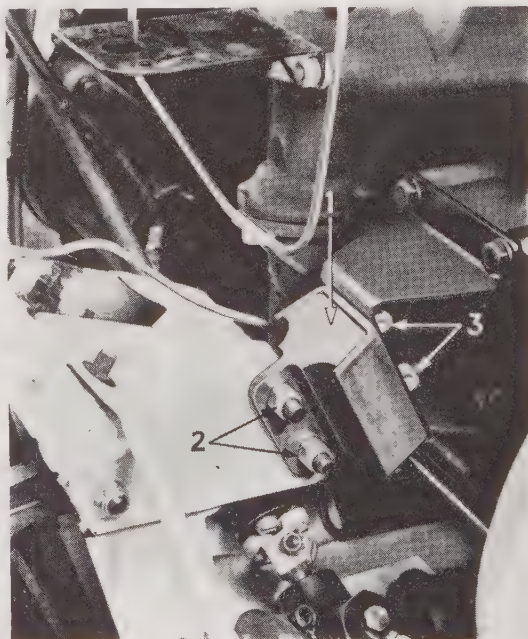


Fig 1:6 Front engine mounting.

Key to Fig. 1:6 1 Flexible mounting. 2 and 3 Fixing bolts and nuts.

1 : 20. For use with reground journals, undersized bearing shells are available. The small-end bush is a press-fit, and a worn bush can be removed and a new one inserted in one operation, after which the bush is reamed to size. This work is however best done by an agent.

1 : 9 Pistons

Markings on the pistons give a good indication of connecting-rod accuracy; a heavy skirt marking above the gudgeon pin on one side, along with a similarly heavy marking below the pin on the other side, means that the rod is probably bent. It must either be straightened or a replacement rod fitted. Rod straightening requires expert use of a special fixture available to agents, to whom such work should be entrusted. When the connecting-rods are assembled with their pistons, the split in the piston skirt must be on the side of the rod corresponding to the upward slope of the big-end split, i.e. the split faces the camshaft when installed, so as to be on the non-thrust

side during the power stroke; this is shown on **FIG 1 : 17**. Connecting-rods and pistons must be reassembled in their original cylinder bores.

Each piston has two compression rings, the upper one being chromium-plated and the lower one taper-faced. Below these there is a slotted oil-control ring. The fully floating type of gudgeon pin is hollow and located end-ways by circlips seating in grooves in the piston bosses. As shown in the Appendix, there are three available pin diameters, graded by colour identification, to ensure correct fitting in the bosses and small-end bush.

The pressed-in type of gudgeon pin requires the use of a special tool, expertly applied, for removal and replacement. If it is desired to separate the piston and connecting-rod in such cases, the work should be entrusted to a Triumph agent. With this pressed-in pin there is of course bearing movement in the piston bosses only.

To check cylinder wear, a cylinder gauge of Mercer or similar type should be used as on **FIG 1 : 21**. Readings

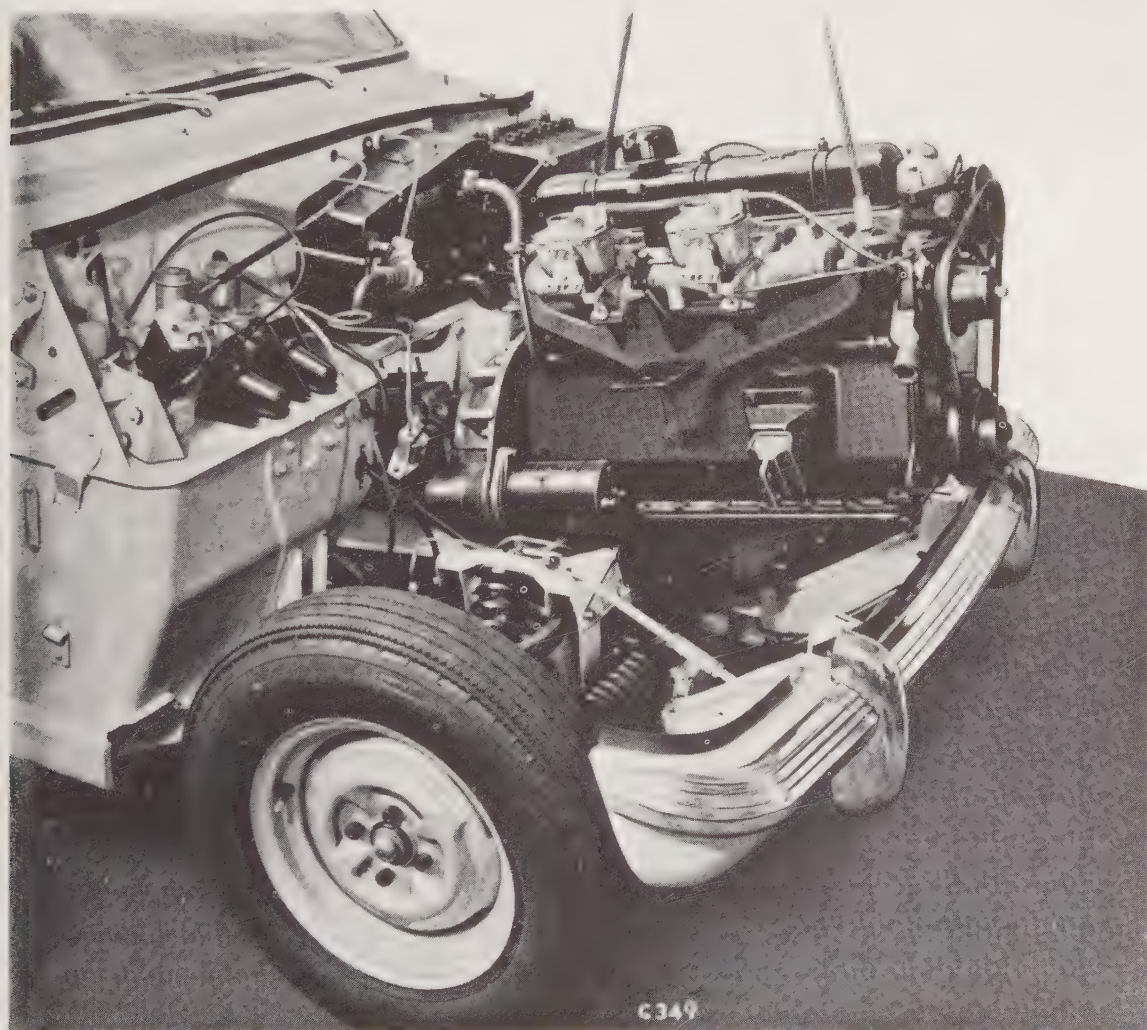


Fig 1 : 7 Removal of 6-cylinder engine from car

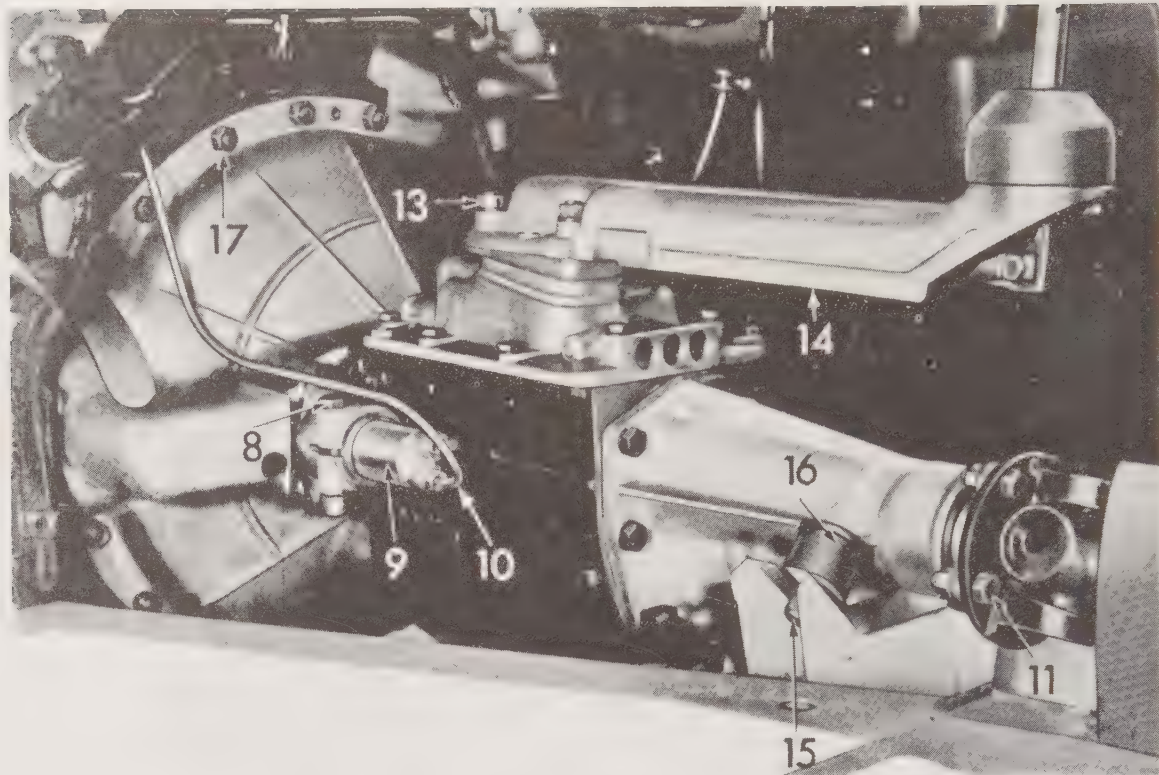


Fig 1:8 Bellhousing and gearbox details.

Key to Fig 1:8 8 Clutch slave cylinder pinch-bolt.

13 Remote control attachments.

9 Slave cylinder.

15 Rear mounting nuts.

10 Fluid pipe.

16 Rear-mounting.

11 Universal joint bolts.

17 Clutch housing nuts.

should be taken at different positions in the bore both up and down the stroke and across the diameter. Maximum wear will invariably be found to occur towards the top of the cylinder, on the axis at right-angles to the crankshaft, which is the point of maximum thrust. When worn beyond acceptable limits, reboring is necessary as detailed in the Appendix. If the maximum rebore diameter listed is insufficient, the cylinder block can be bored out to receive pressed-in liners.

1:10 Flywheel

The cast-iron flywheel is secured to the crankshaft flange by four bolts and located by a dowel, to ensure that it is replaced in the correct position for engine balance. The flywheel face forms one of the friction surfaces for the clutch driven plate, and is subject to wear. If serious scoring occurs the wheel should be renewed or the face skimmed in a lathe. In the latter case, the maximum permissible run-out figure is 0.003 in (0.0762 mm) relative to the spigot face, this being measured at a radius of 5 in. The wheel balance (free) should be within $\frac{1}{16}$ oz. The starter gear ring is a shrunk-on fit on the wheel rim. If it is worn to excess, the ring can be removed by supporting the wheel on blocks so that the ring is clear of the bench, and drifting the ring off its register with a hammer and copper drift.

A new ring is fitted (after ensuring that the seating surface on the wheel is perfectly clean) by immersing the ring in boiling water to raise it to the required temperature. The ring is then placed on the flywheel rim and pressed home. This is best done by using a series of clamps as shown on FIG 1:22, but the same result can be achieved by expert and careful use of a hammer and soft copper drift. The ring must never be heated other than by the foregoing method; a flame for example will damage the hardening of the gear teeth.

1:11 Oil pump removal

The oil pump (FIG 1:16) can be taken off after unscrewing its three bolts. With the end-cover removed, the rotors may be examined for wear. Their clearance is checked by feeler gauge between the tips of the inner rotor lobes and the humps of the outer segments; this must not exceed 0.010 in. The diametrical clearance between the outer circle of the outer rotor and its corresponding bearing surface in the pump body should be checked, and this also must not exceed 0.010 in. The rotors are supplied in matched pairs, and excessive clearance can only be remedied by fitting a new pair; if the body to outer rotor clearance is excessive, the wear may be in the pump body, in which case this should be renewed. A straight-edge is next placed across the face of the body which receives the

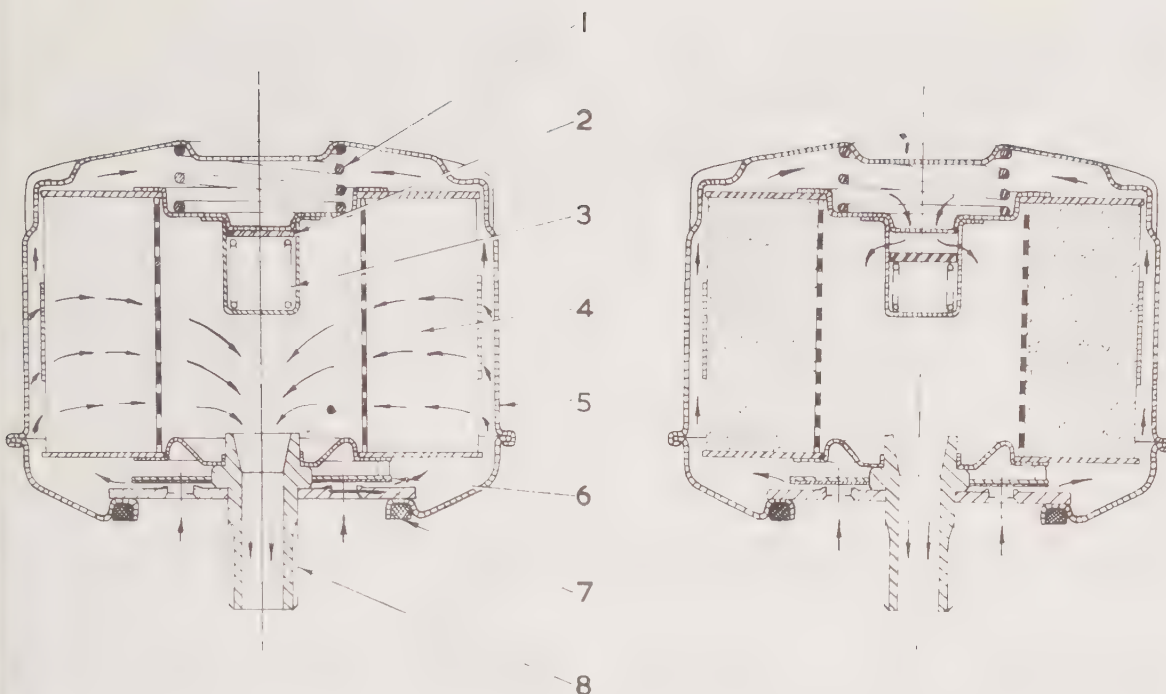


Fig 1:9 Oil-filter, 4-cylinder engines. Diagram on right shows by-pass operation with blocked element.

Key to Fig 1:9 1 Spring. 2 By-pass valve. 3 Valve spring. 4 Filter element. 5 Casing. 6 Base. 7 Gasket. 8 Outlet spigot.

bottom cover. There should be a maximum of 0.004 in between the end-faces of the rotors and the straight-edge. If this amount is exceeded, the body face may be lapped on a flat surface-plate to correct. No gaskets are used in the various pump faces. These various measurements are clarified on **FIG 1:23**.

Access to the oil-pressure relief valve is obtained by removing the domed nut which is screwed into the crank-case side just above the pump. Beyond thoroughly cleaning, no attention should be required. The valve comprises a spring-loaded plunger, the spring being graded to by-pass at a pressure of 50–55 lb/in² (3.5–3.9 kg/cm²). No attempt should be made to restore failing oil pressure by fitting a stronger spring, or packing the spring with washers or other makeshifts; a fall in pressure is indicative of more serious trouble. The minimum pressure when idling with the warning lamp illuminated is 5–7 lb/in² (0.35–0.49 kg/cm²). It will be noted that the filter element on full-flow filters is spring-loaded, so that if the pressure difference across the element becomes excessive due to choking, the element is short-circuited. This obviously allows unfiltered oil to pass to the gallery, and must never be allowed to happen. The oil circulation system is shown on **FIG 1:24**.

The cylinder head is of high-grade cast-iron, with bath-tub combustion chambers. The valve ports are brought out to the offside, while the spark plug bosses are inclined at an upward angle on the nearside, the push-rod tunnels

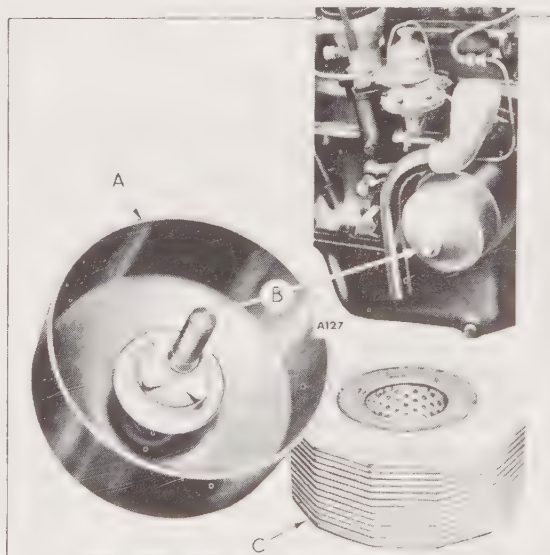


Fig 1:10 Oil filter and mounting on 6-cylinder engines.

Key to Fig 1:10 A Casing. B Centre bolt. C Filter element.

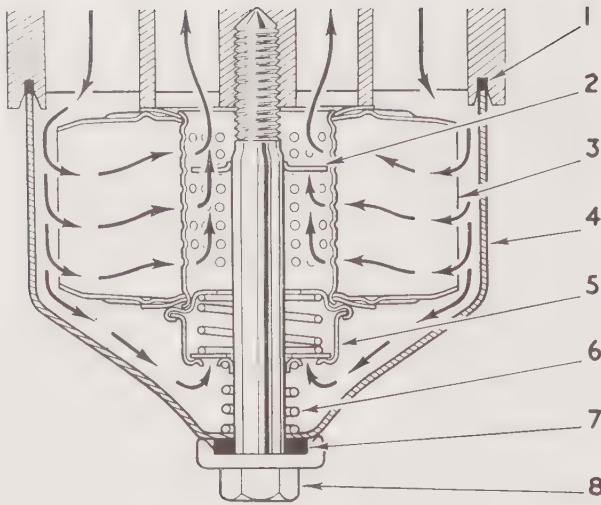


Fig 1:11 Oil filter, 6-cylinder engines. Diagram on right shows by-pass operation with blocked element.

Key to Fig 1:11 1 Gasket. 2 Baffle. 3 Filter element. 4 Casing. 5 Spring housing. 6 Main spring. 7 Washer. 8 Main bolt.

being also located at this side. On four-cylinder engines there are ten or eleven studs and nuts to hold down the head, while the six-cylinder units have fourteen. The valve-guides are pressed-in, and readily replaced when worn, as detailed later. The valve seat angle is 45 deg. Seats which have become excessively pitted or worn should be recut, and this work is best entrusted to an agent equipped with the correct equipment. In extreme cases of wear, seat inserts may be fitted, and this again is a job to be 'put out'. If on a reconditioned engine, an insert is found to be loose or damaged it must be renewed and properly located in the casting, using an oversize insert.

1:12 Valves and gear

The valves have a face angle of 45 deg. For both inlet and exhaust they are of high-grade alloy steel as required for the duty. The dimensions for the various engine types are given in the Appendix. Double valve springs are used on six-cylinder engines; four-cylinders have single springs. In all cases the springs are wound with progressively-closing coils towards the lower ends to reduce periodic surge, and must always be fitted in this manner. No special oil-sealing arrangements are provided on the valve-stems, since the close control of lubricant from the rocker bushes makes these unnecessary. The rocker-shaft is supported in aluminium alloy pedestals individually secured to the head by studs. Four pedestals are employed on four-cylinder, and six on six-cylinder engines. There is a rocker against each side of individual pedestals, the rocker pairs being separated and located between the pedestals by spacing springs threaded on the shaft. At each end of the shaft, the overhung rocker is retained axially by means of an end-cap secured to the shaft with a Mills drive-pin. Between each end-cap and the adjacent rocker is a double-coil spring washer. The rear rocker-shaft pedestal is drilled for the oil supply and is also provided with a setscrew to lock the shaft so as to ensure that it is maintained in the correct angular position with regard to oil-holes: **FIG 1:25** shows

the rocker-shaft components. On the latest engines, the end pedestals are shaped to support the extreme end of the rocker shaft, so that the end rockers are no longer overhung.

1:13 General dismantling

The method of dismantling various assemblies will be evident from much of the foregoing, but the following information will cover other points.

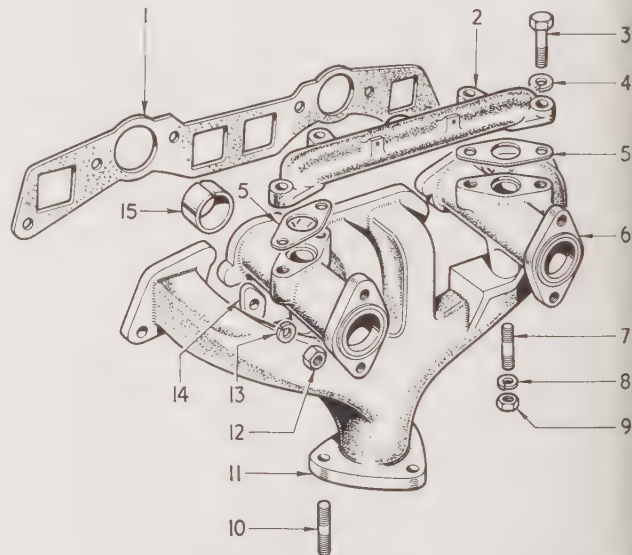


Fig 1:12 Manifolding of 'Spitfire' Mk. I engine (2 inlet port type).

Key to Fig 1:12 1 Gasket. 2 Balance pipe. 3 Bolt. 4 Spring washer. 5 Gasket. 6 Inlet manifold. 7 Stud. 8 Spring washer. 9 Nut. 10 Stud. 11 Exhaust manifold. 12 Nut. 13 Spring washer. 14 Clamp. 15 Location sleeve.

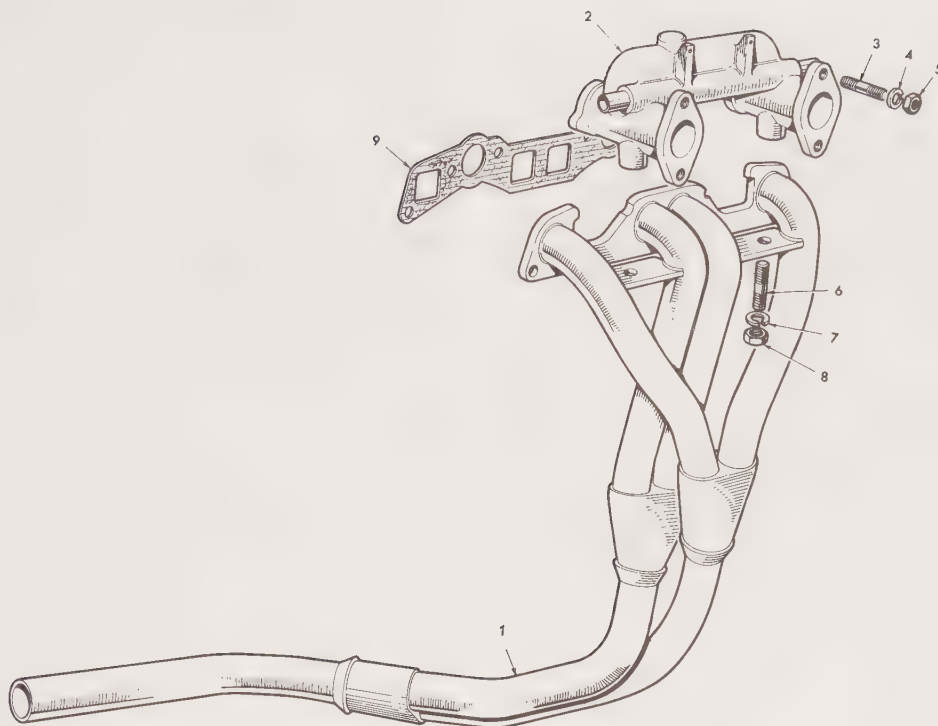


Fig 1:13 Manifolding of 'Spitfire' Mk. II engine, with 2 inlet ports and long-branch exhaust system.

Key to Fig 1:13 1 Exhaust manifold. 2 Inlet manifold. 3 Stud. 4 Spring washer. 5 Nut. 6 Stud. 7 Spring washer. 8 Nut. 9 Gasket.

The generator and its bracket can be removed after slackening the bolts and taking off the driving belt, removing the cables from the two terminals, and then unscrewing the bolts completely. The distributor is withdrawn after disconnecting the vacuum pipe and removing the nuts from the two studs which hold the adaptor housing to the crankcase flange; the unit can then be taken off, along with its driving gear. The oil-pressure tell-tale switch is a screw-fit in the crankcase side. The thermostat is accessible after removing the water elbow at the front of the head; it can be lifted out of its register in the casting. The rocker-shaft assembly is removed by unscrewing the nuts from the holding-down studs. Slacken the nuts a little at a time alternately and evenly, so that there is no bending strain on the shaft under pressure from the valve springs, and lift off the shaft and pedestals as a unit. The shaft can then be dismantled by removing one of the end-caps after taking out the Mills pin, and sliding the components off the shaft. Take care to keep all the components in the correct order for refitting. Note that four-cylinder engines have four pedestals and three spacing springs, while on six-cylinder units there are six pedestals and five springs. The push-rods are next lifted out and these again must be put back in their correct locations. The cylinder head nuts can then be removed in the sequence shown on **FIGS 1:26 to 1:28**, and the head and gasket lifted off.

1:14 Valve removal

To remove the valves a normal G-clamp type of compressor is used. With the spring compressed, the split collets can be extracted, and the collar and spring or springs taken off. The valve components for various engine types are indicated on **FIG 1:29**. The water take-off and thermostat housing can then be removed, and the head is completely dismantled.

On four-cylinder engines the end-nut at the nose of the crankshaft is next unscrewed and the belt pulley drawn off. In the case of six-cylinder engines, a substantial bolt is screwed into the crankshaft end for retention of the fan hub and pulley-damper unit. **FIG 1:30** should be referred to for clarification. To dismantle the crankshaft assembly after removing the sump, the three screws retaining the oil-pump are taken out and the pump removed for subsequent checking as already detailed. Unscrew the big-end cap bolts after bending back the locking plates to clear the heads; tap each bolt-head after unscrewing a few threads, to release the rod from the cap, and remove the bolts and caps completely. The connecting-rods can then be pushed up the bores, taking care not to cause scratching of the latter, and the pistons and rods drawn out of the top. If there is difficulty in getting the pistons to emerge, it is likely that carbon around the top of the bores is causing

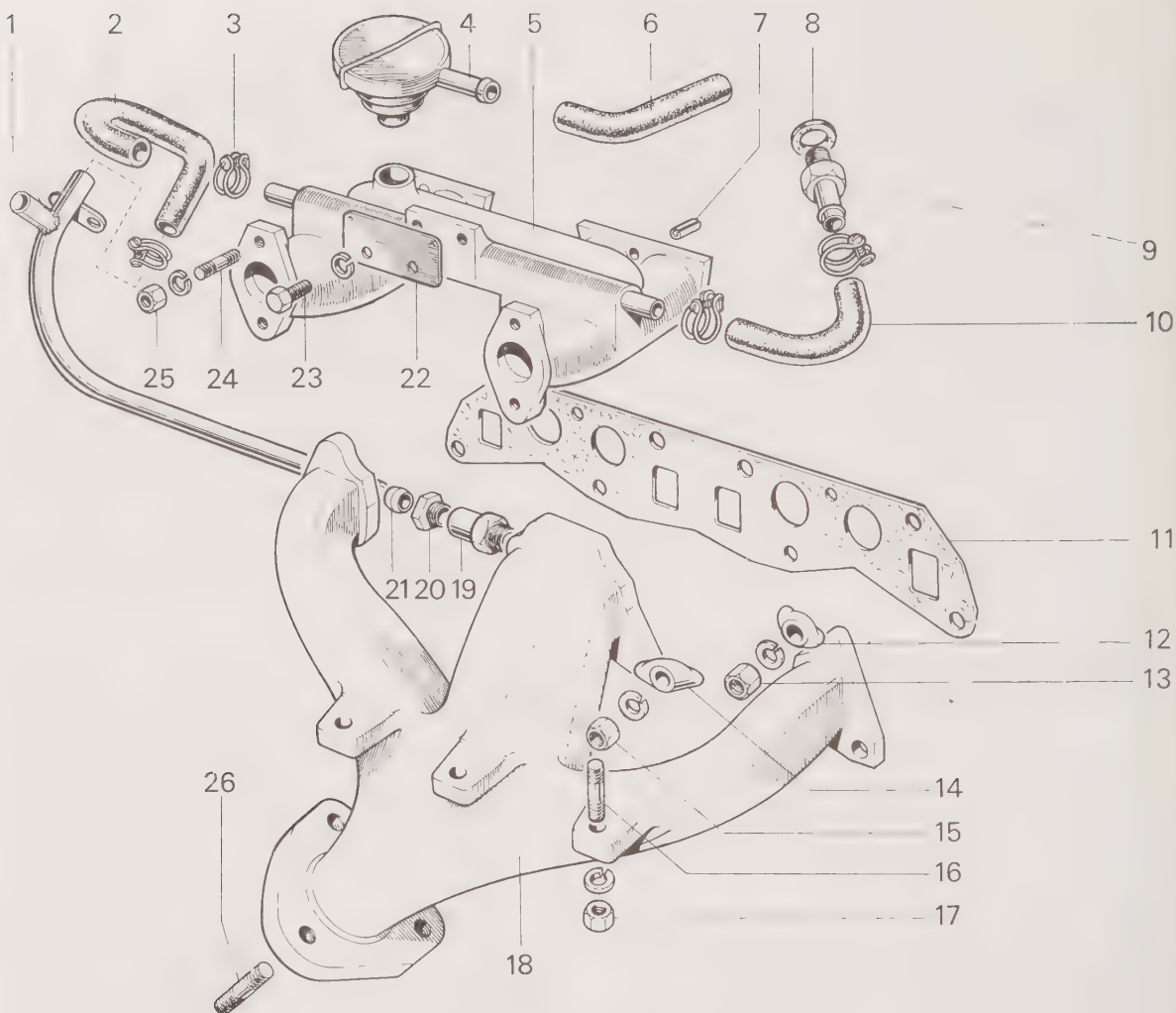


Fig 1:14 Manifolding of 'Spitfire' Mk. III engine (4 inlet ports).

Key to Fig 1:14	1 Heater pipe.	2 Hose.	3 Clip.	4 Breather valve.	5 Inlet manifold.	6 Breather hose.
7 Mills pin.	8 Gasket.	9 Adaptor.	10 Hose.	11 Manifold gasket.	12 Clamp.	13 Nut.
14 Clamp.	15 Nut.	16 Stud.	17 Nut.	18 Exhaust manifold.	19 Adaptor.	20 Union.
21 Olive.	22 Spring plate.	23 Bolt.	24 Stud.	25 Nut.	26 Stud.	

sticking, and this must be carefully scraped away. The clutch assembly is next removed from the flywheel by taking out the screws holding it to the rim; remove diametrically-opposed screws a little at a time, so as to release the spring pressure evenly. The pressure unit and the driven plate can then be lifted away. The two locking plates are next bent away from the heads of the four bolts which secure the flywheel to the crankshaft boss, and the wheel removed.

Now take out the two slotted screws from the sealing block which is positioned over the front main bearing cap (and which forms part of the sump flange face) and remove the block. Having unscrewed the nut or bolt from the nose of the crankshaft, draw off the shaft components.

Take out the timing cover screws and remove the cover (**FIG 1:30**). Bend back the locking plate on the two bolts securing the camshaft sprocket wheel to the shaft hub, and unscrew the bolts. This will allow the large sprocket to be slipped off the shaft, and the endless chain to be lifted off the teeth. The crankshaft sprocket can then be removed, taking care to retrieve its shaft key. The thrust plate at the front of the camshaft bearing is now removed, and the tappets and camshaft withdrawn. Take out the screws securing the front and rear crankcase plates, and remove the plates.

The rear housing (**FIG 1:19**) is next taken off by unscrewing its bolts, and removed complete with the seal if of that type. Mark the main bearing caps so as to ensure

replacement in the original positions, take out the bolts and remove the caps. The crankshaft can then be lifted out.

1:15 Inspection

The power unit is now completely dismantled as far as major assemblies are concerned. All parts must be thoroughly cleaned and checked for condition. The various oilways in the block and head can be cleared by the use of a high-pressure petrol squirt and finally blown through. When replacing blanking plugs in oilways, first apply a good plastic sealer to the screw-threads to prevent leakage or loosening. Examine all tapped holes to ensure that the threads are sound and that there is no possibility of studs or bolts bottoming. This can be caused by hard-packed dirt at the base. Doubtful threads can be corrected and cleared, by running down the appropriate size of tap. The location of the various studs, etc., is given on **FIGS 1:31 and 1:32**.

Components may be checked dimensionally against the data given in the Appendix. If the engine has been dismantled at a major overhaul period, renewal of all gaskets, joint washers, locking plates and oil-seals will be required. If however it is relatively new but has been stripped for a special purpose, e.g. inspection prior to modification, it is possible that some of these items will be quite serviceable even after removal. However, if at all doubtful, re-

newal is most advisable. Assuming that the block is serviceable and with any required renovation carried out to cylinder bores, etc., assembly is largely a reversal of the dismantling procedure.

1:16 Crankshaft replacement

If the crankshaft requires reconditioning, the dimensions given in the Appendix relating to bearing clearances must be strictly adhered to. To check end-float is necessary for the shaft to be in position in the bearings, and then to move it axially as shown on **FIG 1:33** at the same time measuring the movement, which can be done by feelers or a dial gauge. The float is determined by the thickness of the thrust washers on each side of the rear bearing, and is correct at 0.004 to 0.006 in (0.1 to 0.15 mm). If the movement is excessive, oversize washers must be fitted. Should the shaft be reground to include the flanks of the rear journal which bear against the washers, an equal amount of metal must be removed from each flank. If balanced on knife edges, the maximum out-of-balance of the shaft should not exceed 0.3 oz/in. When mounted between centres, as shown on **FIG 1:34**, the run-out of the centre main journals should not be more than 0.001 in (0.025 mm), the same dimension being a maximum for run-out of the rear face and periphery of the flywheel boss. Ground surfaces on the shaft must be finished to 7-12 micro-

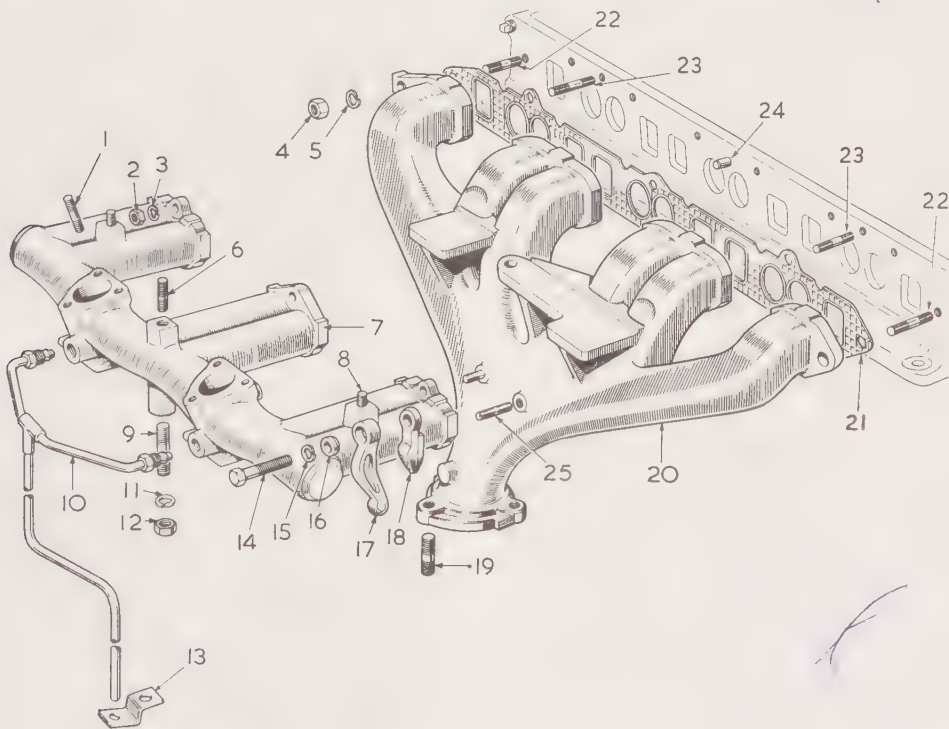


Fig 1:15 Manifolding of 1600 cc 6-cylinder engine (Solex carburettors).

Key to Fig 1:15 1 Stud—carburetter. 2 Nut. 3 Spring washer. 4 Nut. 5 Spring washer. 6 Stud. 7 Inlet manifold. 8 Stud. 9 Stud—inlet to exhaust manifold. 10 Drain pipe. 11 Spring washer. 12 Nut. 13 Clip. 14 Bolt. 15 Spring washer. 16 Coned washer. 17 Clamp. 18 Clamp pivot. 19 Stud—exhaust flange. 20 Exhaust manifold. 21 Gasket. 22 Stud. 23 Stud. 24 Dowel. 25 Stud—air cleaner bracket.

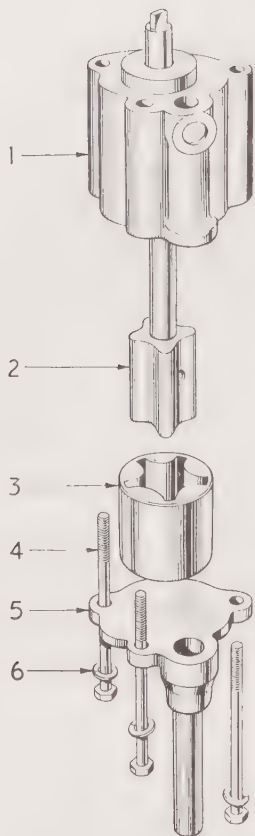


Fig 1:16 Oil pump dismantled.

Key to Fig 1:16 1 Body. 2 Inner rotor. 3 Outer rotor.
4 Fixing bolts. 5 End cover. 6 Spring washers.

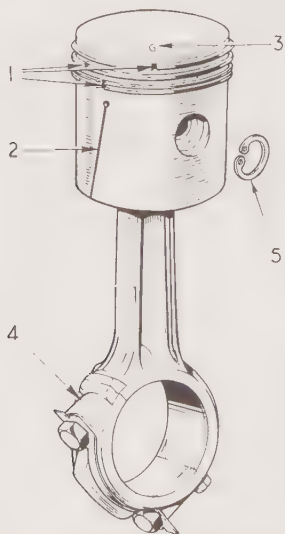


Fig 1:17 Piston and connecting-rod assembly.

Key to Fig 1:17 1 Piston rings. 2 Split in skirt. 3 Crown marking.
4 Big-end cap. 5 Circlip for gudgeon pin.

inches, and should cover the complete radius of the fillets.

To replace the shaft the main bearing half-shells are first positioned in the crankcase webs, taking care that their locating tabs are properly engaged in the recesses provided. Oil the crankshaft main journals, and carefully lower the shaft on to the bearings, at the same time fitting the two thrust washers to the rear journal with their white-metal faces bearing against the crankshaft faces, as shown on **FIG 1:35**. Fit the other half bearing shells into the caps, oil the surfaces liberally, and fit the caps over the shaft. Bolt up securely and check the shaft end-float. When this is confirmed as correct, the bolts should be tightened evenly to a torque of 50–55 lb/ft. The front sealing block is next replaced over the bearing cap, after first coating its ends with jointing compound. Fit and tighten the two securing screws making sure that the block is accurately aligned with the front face of the crankcase, otherwise oil leakage may occur. When the block is secured, drive two wood filler-wedges into the recesses on each side of the block, and cut them off flush with the block face which forms the flange face for the sump (see **FIGS 1:1** and **1:3**). When fitting the rear housing to the shaft, a new paper washer must always be used, coated on both sides with jointing compound. If the seal is of the earlier scroll-type, the housing bolts must be inserted finger tight, and a feeler gauge employed to obtain a consistent clearance of 0.003 in. between the housing and the shaft as shown on **FIG 1:36**. This applies to aluminium housings; for the later type of cast-iron housing, the clearance is reduced to 0.002 in. When this is correct, tighten the bolts to a torque of 16–18 lb/ft, and re-check the clearance. If a non-metallic flexible seal is used as on the latest cars,

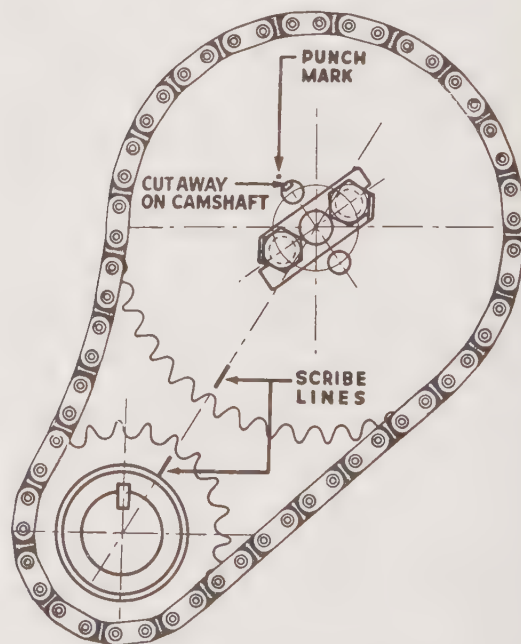
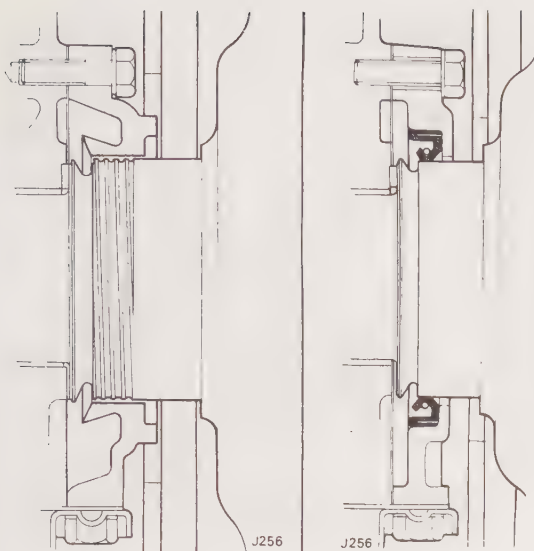


Fig 1:18 Camshaft drive, showing markings, etc., to ensure correct relationship of parts.



Scroll type

Seal type

Fig 1:19 Types of crankshaft rear oil seal.

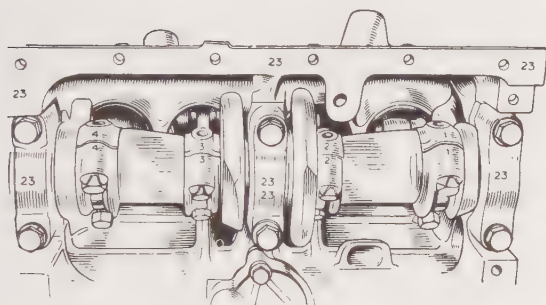


Fig 1:20 Identification markings on main and big-end bearing caps.

the housing should be prepared as before, but it is necessary to centralize the seal on the shaft with a suitable tool, the Triumph device being Part No. S335. The sealing lip must be towards the shaft as shown on **FIG 1:19**. The shaft and sealing ring should be oiled liberally before fitting. When all is correct, tighten the housing bolts as already detailed. Fit the rear engine plate after ensuring that its two dowels are secure in the crankcase wall, and tighten the bolts to a torque of 18–20 lb/ft.

The front engine plate is fitted similarly. Next see that the dowel is properly positioned in the flywheel flange of the crankshaft, and turn the shaft so that the two end crankthrows are vertical. Offer up the flywheel to the flange with the tdc marking at the top; in this position the dowel hole should also line-up. If all is well, position the wheel firmly on the flange and insert the bolts with the locking plates under them. Tighten the bolts, and check the flywheel face for run-out as described earlier. If this is

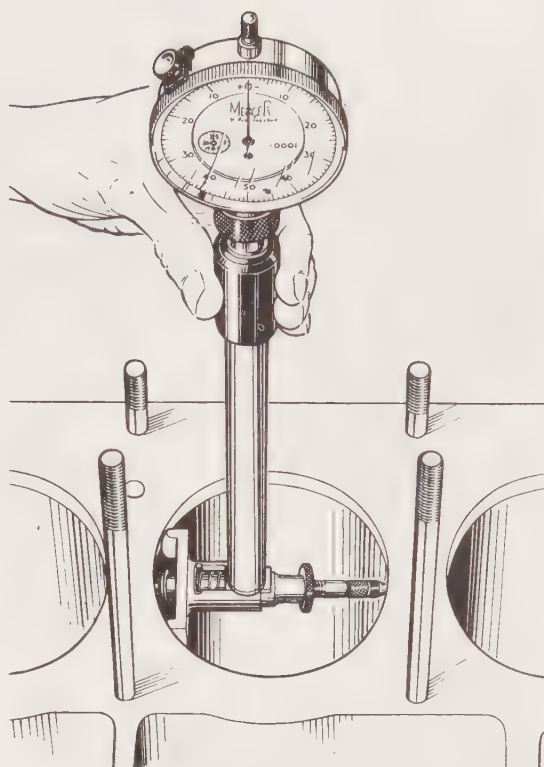


Fig 1:21 Measuring cylinder bore wear by means of a dial gauge.

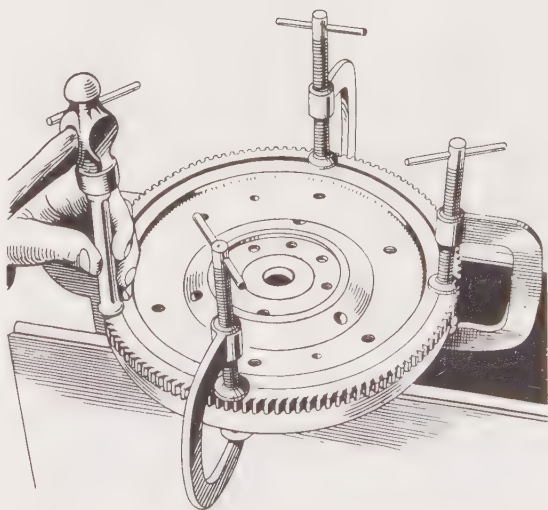


Fig 1:22 Method of replacing starter gear-ring on flywheel.

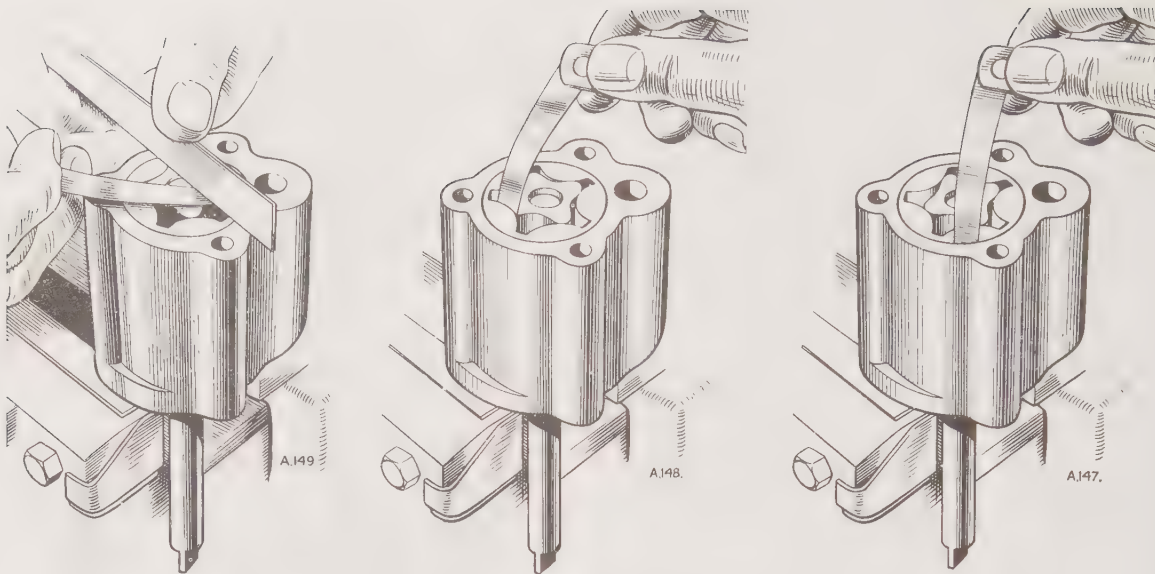


Fig 1:23 Method of measuring wear on oil-pump components, as described in text.

correct, tighten the bolts to a torque of 42–46 lb/ft and bend the locking tabs firmly over the heads.

1:17 Camshaft and drive

The camshaft may next be inserted into its bearings after first oiling the journals. Retain the shaft by fitting the thrust plate as shown on FIG 1:37, tightening the plate screws to 18–20 lb/ft torque. Note how many shims were removed from the crankshaft shoulder locating the small sprocket, as seen on FIG 1:38, and replace the same number on the shaft. Next fit the key to the shaft keyway; it must be a firm fit without shake in either shaft or

sprocket. Fit the sprocket and press it home firmly against the shims and shoulder. The camshaft sprocket wheel, without the chain, must now be attached to the camshaft by its two screws and the latter tightened. Place a straight-edge across the sprocket faces as shown on FIG 1:39 to check the alignment. When doing this, both the crankshaft and camshafts must be pushed in the same direction axially, so as to take up all their clearance. If the sprocket alignment needs correction, add or remove shims from behind the crankshaft sprocket until all is in order. The two sprockets should then be removed.

Next rotate the crankshaft until the two end throws are vertical at tdc. The flywheel marking should then line up with a similar mark on the cylinder block, and the sprocket key will be pointing upwards also at tdc. Note also that a mark on the sprocket periphery will point towards the camshaft centre (FIG 1:18). The camshaft sprocket wheel is punch-marked adjacent to one of its fixing holes, and this must be lined-up with the small cut-out on the camshaft boss. Bolt the sprocket to the shaft and turn the latter until its peripheral line is directly in line with the one on the small sprocket, as shown on FIG 1:18. Leaving both the crankshaft and camshaft in these positions, remove both sprockets and encircle them with the chain, at the same time keeping the two timing marks lined up as before. Then fit the drive complete to both shafts. Insert the camshaft bolts with their locking plate, and tighten to a torque of 24–26 lb/ft.

There is no difficulty about obtaining the correct timing with unmarked sprockets. The crankshaft is turned as before, and the camshaft is then turned until the cams for the two valves on No. 1 cylinder are at their tdc point of balance, i.e. exhaust just closing and inlet just opening (FIG 1:40). The wheels and chain are then fitted. This camshaft position however is preferably arrived at with the cylinder head and valve mechanism in position. In that case, the camshaft (without the sprocket) is turned until

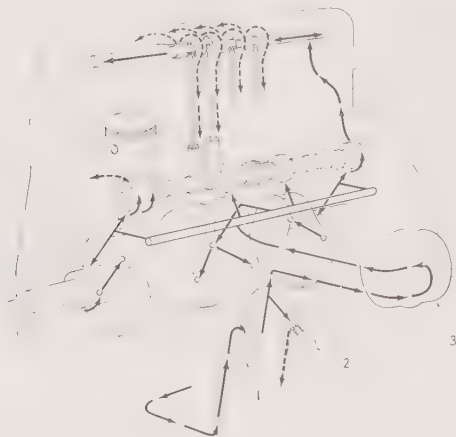


Fig 1:24 Oil circulation system as typified by 4-cylinder engine.

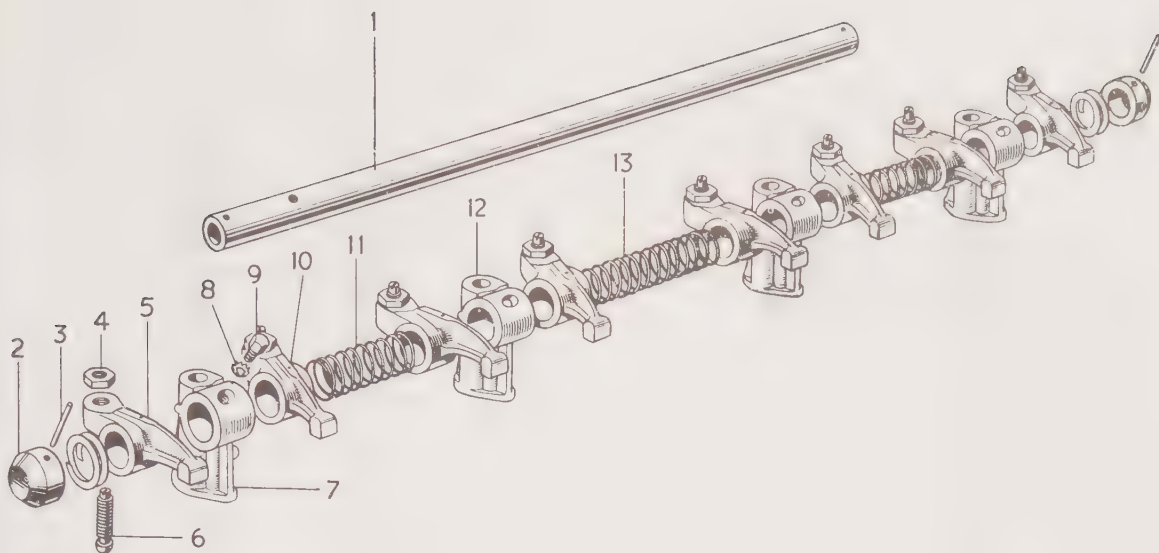


Fig 1:25 Rocker-shaft and components.

Key to Fig 1:25 1 Rocker shaft. 2 End cap. 3 Mills pin. 4 Locknut. 5 Rocker—RH. 6 Adjusting screw. 7 Pedestal (rear). 8 Shakeproof washer. 9 Locating setscrew. 10 Rocker—LH. 11 Spring (outer). 12 Pedestal. 13 Spring (centre).

the valve at the rear or flywheel end of the engine is fully open. No. 1 valve is then adjusted to a clearance of 0.040 in (1 mm). This procedure is repeated on No. 2 valve, so that both valves on No. 1 cylinder have a large clearance. If the camshaft is now slowly turned, it is easily possible to ascertain the point at which the clearances between the valve stems and rocker-ends on No. 1 cylinder are precisely equal; this is the point of balance.

Some timing adjustment is available due to the camshaft sprocket having four holes. It will be noted that these are spaced at 90 deg but are offset from a tooth centre. Thus, a half-tooth adjustment can be obtained by turning the sprocket through 90 deg from the original position, while a quarter-tooth variation is achieved if the wheel is first fitted back to front and then rotated through 90 deg. These adjustments should not normally be required, particularly if the camshaft drive is in good condition. The chain and sprocket teeth are fairly heavily loaded, particularly on the high-powered engines, and if there are signs of undue tooth wear, evidenced by a hooked shape, they should be replaced along with the chain. The amount of chain wear can be gauged by using a straightedge as shown on **FIG 1:41**, with the drive in position.

1:18 Pistons and rings

The pistons are removed from the connecting-rods by removing the circlips and pressing out the pin. The dimensions given in the Appendix for the pin and small-end bush should be noted, as it is essential to have an accurate fit in this component. If any renovation of connecting-rods is called for, in the way of rebushing or straightening, the work must be given to an accredited agent. This comment also applies to gudgeon pins which are not circlip-retained, as already mentioned.

The piston dimensions given in the Appendix are measured as shown on **FIG 1:42**, being the maximum at

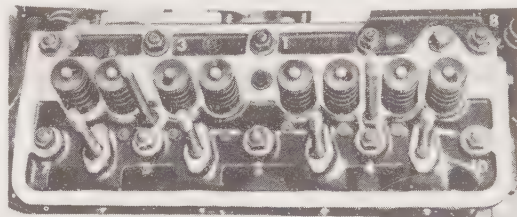


Fig 1:26 Cylinder head nut tightening and slackening sequence, 'Spitfire', 10-studs.



Fig 1:27 Cylinder head nut tightening and slackening sequence, 'Spitfire', 11-studs.

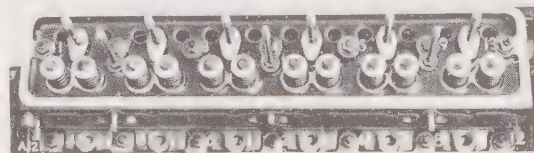


Fig 1:28 Cylinder head nut tightening and slackening sequence, 6-cylinder.

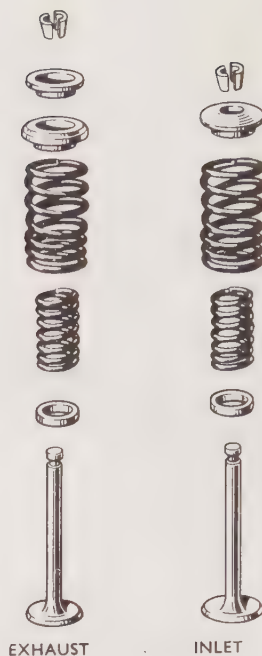
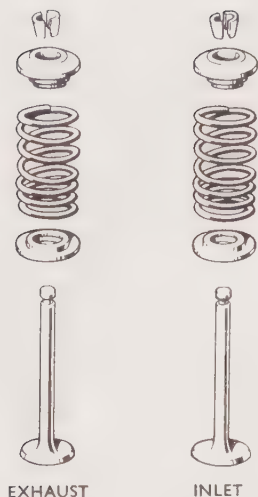


Fig 1 : 29 Valves and components. Left 'Spitfire'. Right 'Vitesse' and GT.

the thrust faces at the bottom (AA) and top (BB) of the skirt. The maximum variation in weight between a set of pistons must not exceed 4 drams (2 drams on 'Spitfire' Mk. III). Each piston has rings of the type shown on FIG 1 : 43. The top compression ring is plain, and the second taper-faced. The latter must be fitted with the taper towards the top, giving maximum clearance to the bore at this point. The ring is marked T or Top, on its upper face for indication.

The ring dimensions are as stated in the Appendix for the various types. To measure the gap, insert the ring into the cylinder bore, using one of the pistons to push the ring squarely in, until it is at a point 0.25 in (6 mm) from the top. The gap may then be measured with a feeler gauge as shown on FIG 1 : 44. Note also the ring-to-groove clearances, which must be adequate but not excessive. Before refitting the pistons to the connecting-rods, ensure that all oil-feed holes are unobstructed, and the parts are scrupulously clean. Immerse the piston in boiling water to heat it, which will facilitate fitting of the gudgeon pin; slip the latter through the bosses until it is central between the circlip grooves. Then refit the circlips, making sure that the grooves are clean and that the circlips bed down tightly. New circlips should always be used, even if the ones removed seem in good condition, as failure can have serious consequences. Oil the piston freely after shaking off any surplus water, and fit the rings as already detailed. To refit the pistons and rods to the block, the latter must be positioned so as to give access both to the top and bottom. Space the ring gaps at equal circumferential distances of 120 deg and push

the piston into the bore from the top, making sure that the connecting-rod is the right way round with the upward slope of the big-end face towards the camshaft. Using a piston ring squeezer over the rings, carefully ease the piston and rod down the bore as shown on FIG 1 : 45, and at the same time rotate the crankshaft until the appropriate crankthrow aligns with the big-end of the rod. Oil the crankpin liberally, fit the bearing shell into the rod with its locating tab properly in the recess, and push the rod-end over the crankpin. Fit the corresponding bearing shell into the cap, place the cap over the crankpin in the same position as when removed, and insert the bolts along with locking plate. The bolts are then lightly nipped. Fit all the rods and pistons in this manner, turning the shaft as required between each fitting. The cylinder bores must now be liberally oiled.

The crankshaft can then be turned and all motions checked (watch the crankshaft sprocket to make sure it remains positioned, in the absence of its securing device). If all is well, tighten all the big-end bolts to a torque of 42–46 lb/ft, and carefully lock the bolts with the plates.

The oil pump can next be assembled after checking as already detailed. Fit the inner rotor and shaft into the pump housing, and follow this by the outer rotor, with its chamfered edge leading. Put on the cover and note that the suction pipe must face the rear. Offer the pump to the crankcase flange and insert the bolts. Tighten the latter to a torque of 6–8 lb/ft. Note that no paper or other joints are used in any of the faces.

Unless it is required to check the camshaft timing (with unmarked sprockets) the timing cover may next be replaced.

1:19 Chain cover assembly

First inspect the crankshaft oil seal for condition, and if this is at all doubtful, press out the old seal and fit a new one. The spring blade of the chain tensioner must be replaced, if unduly worn where it bears on the back of the chain. It is removed by opening out the blade so as to spring it over the pivot pin. A new blade is fitted similarly.

The oil thrower is next positioned against the crankshaft chain sprocket with its dished face outwards, noting that it is notched to slide over the shaft key. Oil the lip of the seal, ensure that the gasket faces of the timing cover joint are perfectly clean, and fit the gasket over the dowels. With the chain tensioner blade pressed in to clear the chain, as shown on **FIG 1:46**, fit the cover over the crankshaft; the tensioner can be released as soon as it is over the chain. Fit the cover bolts, and tighten to a torque of 8–10 lb/ft.

On 'Spitfire' engines, the pulley is now fitted, its long boss being entered carefully into the oil-seal after first lubricating the boss; there is a chamfer to facilitate entry. Six-cylinder engines have a damper unit with boss to run in the oil-seal and this, like the pulley, is keywayed to engage the shaft key (**FIG 1:30**). The nut or end-bolt is then fitted and tightened. Before replacing the sump,

inspect the crankcase interior to make sure that it is thoroughly clean and that no foreign matter has entered during the previous work. It is advisable to use a new gasket on the flange joint, and extreme accuracy in fitting is essential to avoid oil leaks. The sump also must be cleaned out with petrol, and when all is satisfactory it may be replaced, tightening the bolts to a torque of 16–18 lb/ft.

1:20 Distributor drive

The distributor drive gear is next assembled; care is necessary, as an end-float of 0.003 to 0.007 in (0.076 to 0.178 mm) is required on the gear which also drives the oil pump, and no end-thrust must be present on the combination. First insert the oil-pump drive shaft downwards through the bush, and turn it so that its tongue engages the slot in the top of the pump rotor shaft. Next measure the thickness of an ordinary plain steel washer of a size that will locate in the position shown on **FIG 1:47**, fit the skew gear over the shaft, and fit the distributor pedestal. The presence of the washer will produce a gap between the pedestal flange and the engine block as shown; this should be measured by feeler gauge. Remove the distributor head and washer, and measure the washer thickness. If the gap measured by the feeler is subtracted from the

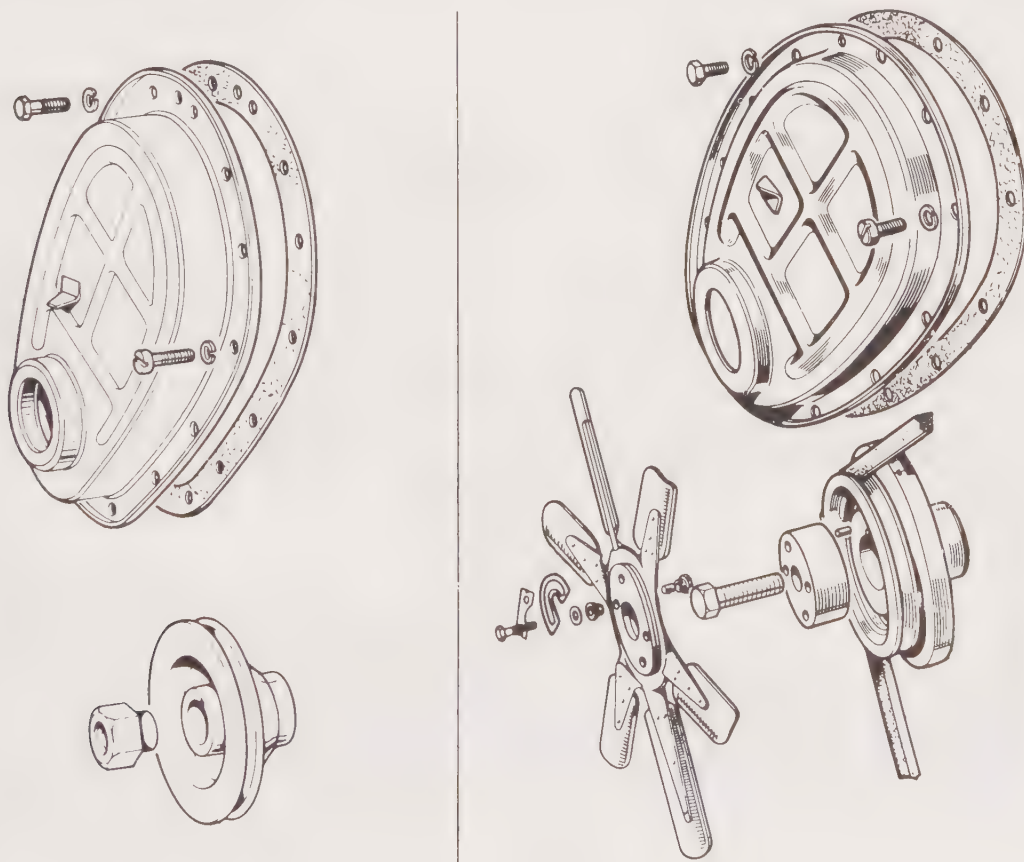


Fig 1:30 Crankshaft pulley and timing case. *Left* 'Spitfire'. *Right* 'Vitesse' and GT6.

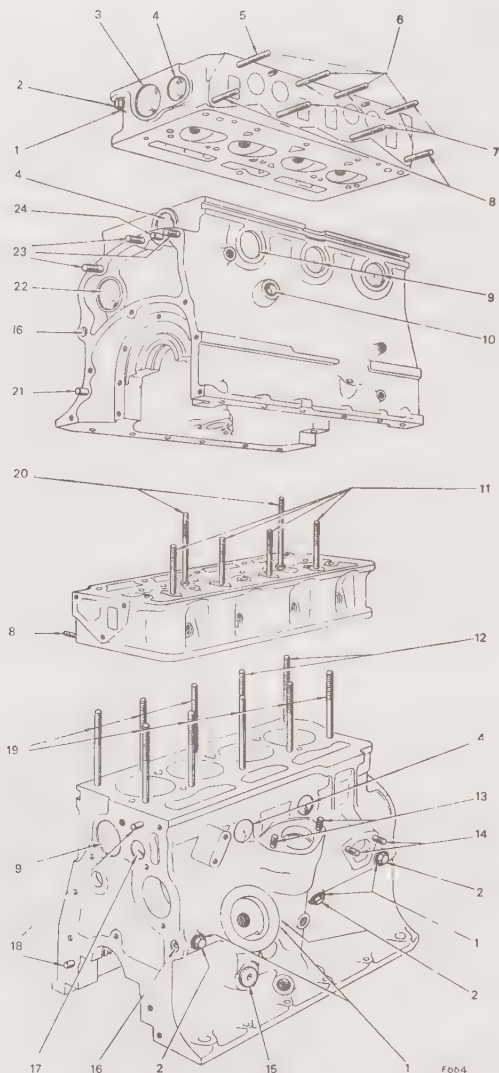


Fig 1:31 Location of studs, dowels, etc., on 4-cylinder block and head.

Key to Fig 1:31 1 Washer—Copper (rocker feed, oil gallery). 2 Setscrew, $\frac{1}{8}$ in UNF $\times$.44 in (rocker feed, oil gallery). 3 Core plug, $1\frac{1}{8}$ in (rear of head). 4 Core plug, $1\frac{1}{2}$ in (rear of head, block rear, block LH). 5 Stud, $\frac{3}{8}$ in UNF $\times$ 1.75 in (manifold inner, 'Spitfire' 3). 6 Stud, $\frac{3}{8}$ in UNF $\times$ 1.84 in (manifold inner, 'Spitfire' 3). 7 Stud, $\frac{3}{8}$ in UNF $\times$ 1.84 in (manifold inner, 1200, 12/50, 'Spitfire' 1 and 2). 8 Stud, $\frac{3}{8}$ in UNF $\times$ 1.34 in (manifold outer). 9 Core plug, $1\frac{1}{2}$ in (block front, block RH). 10 Plug, $\frac{3}{4}$ in (breather seal, 13/60 and 'Spitfire'). 11 Stud, $\frac{3}{8}$ in UNF $\times$ 3.09 in (rocker pedestal). 12 Stud, $\frac{3}{8}$ in UNF $\times$ 4.38 in (lifting eye). 13 Stud, $\frac{1}{2}$ in UNF $\times$ 1.34 in (distributor). 14 Stud, $\frac{1}{2}$ in UNF $\times$ 1.16 in (petrol pump). 15 Plug (oil gallery). 16 Plug (oil gallery). 17 Core plug, 1 in (block—front). 18 Dowel, $\frac{1}{2}$ in $\times$ $\frac{7}{8}$ in (front plate). 19 Stud, $\frac{3}{8}$ in UNF $\times$ 4.19 in (cylinder head, 1200, 12/50, 'Spitfire' 1 and 2 only). 19 Stud, $\frac{3}{8}$ in UNF $\times$ 4.19 in (cylinder head, 13/60 and 'Spitfire' 3 only). 20 Stud, $\frac{1}{2}$ in UNF $\times$ 4.13 in (rocker cover). 21 Dowel $\frac{3}{8}$ in $\times$ $\frac{1}{2}$ in (rear plate). 22 Core plug, 2 in (camshaft rear). 23 Stud, $\frac{1}{2}$ in UNF $\times$ 1.131 in (rear plate). 24 Dowel, $\frac{3}{8}$ in $\times$ 1 in (rear plate).

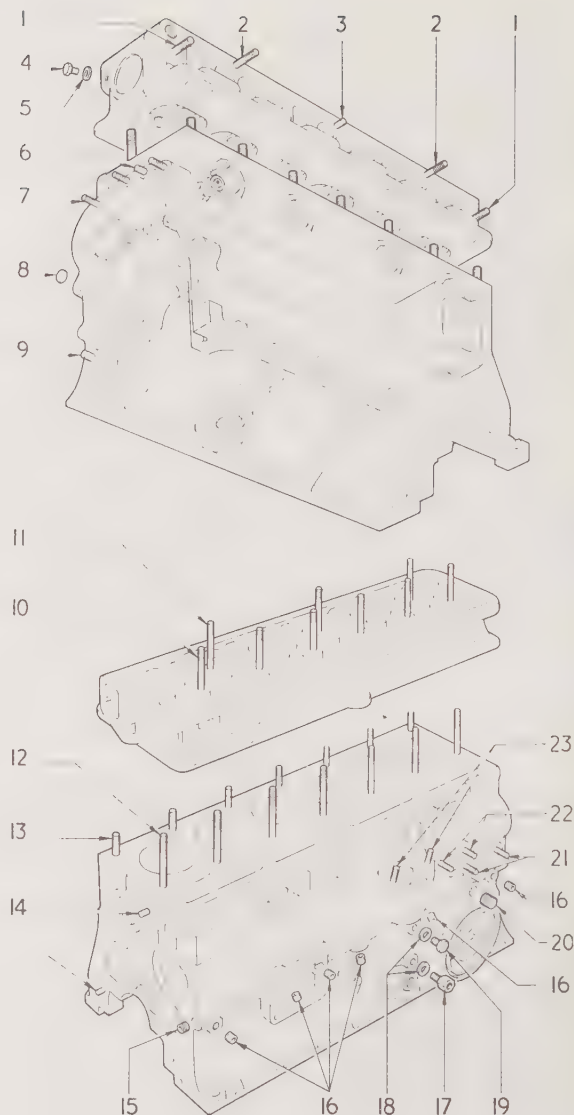


Fig 1:32 Location of studs, dowels, etc., on 6-cylinder block and head.

Key to Fig 1:32 1 Stud, $\frac{3}{8}$ in UNF $\times$ 1.34 in. 2 Stud, $\frac{1}{2}$ in UNF $\times$ 1.38 in. 3 Dowel. 4 Setscrew, $\frac{1}{8}$ in UNF $\times$ $\frac{3}{8}$ in. 5 Copper washer, $\frac{1}{8}$ in I/D. 6 Dowel, $\frac{3}{8}$ in $\times$ 1 in. 7 Stud, $\frac{1}{2}$ in UNF $\times$ 1.31 in. 8 $\frac{1}{2}$ in NPSL dry seal plug. 9 Dowels, $\frac{3}{8}$ in $\times$ $\frac{1}{2}$ in. 10 Stud, $\frac{3}{8}$ in UNF $\times$ 3.09 in. 11 Stud, $\frac{1}{2}$ in UNF $\times$ 4.13 in. 12 Stud, $\frac{3}{8}$ in UNF $\times$ 4.44 in HC; stud, $\frac{3}{8}$ in UNF $\times$ 4.63 in LC. 13 Stud, $\frac{3}{8}$ in UNF $\times$ 1.44 in HC; stud, $\frac{3}{8}$ in UNF $\times$ 1.56 in LC. 14 Dowel, $\frac{1}{2}$ in $\times$ $\frac{7}{8}$ in. 15 Plug, $\frac{1}{2}$ in NF $\times$.38 in. 16 $\frac{1}{8}$ in NP dry seal plug. 17 Oil pressure switch adaptor. 18 Copper washer, $\frac{1}{4}$ in I/D. 19 Setscrew, $\frac{1}{8}$ in UNF $\times$ $\frac{1}{2}$ in. 20 Plug, $\frac{3}{4}$ in UNF $\times$ $\frac{1}{2}$ in. 21 Stud, $\frac{1}{2}$ in UNF $\times$ 1.16 in. 22 Stud, $\frac{1}{2}$ in UNF $\times$ 1.16 in. 23 Stud, $\frac{1}{2}$ in UNF $\times$ 1.31 in.

washer thickness, the end-float requirement can thus be gauged. For example, if the washer thickness is 0.062 in and the gap is 0.060 in (1.57 and 1.52 mm respectively) the end-float will be 0.002 in (0.05 mm). However, a float of 0.002 in is insufficient. Therefore, packing of 0.003 in (0.08 mm) thickness will be required in the flange to give the necessary end-float of 0.005 in (0.12 mm) which represents the mean of the end-float tolerances.

Or again, if the washer thickness is as before but there is a gap of 0.065 in (1.65 mm) this gives a float of 0.003 in and packing will be required of 0.008 in thickness (0.12 mm).

When the packing thickness has been arrived at as above, the skew gear may be timed. First position the crankshaft at tdc of the compression stroke on No. 1 cylinder (both valves fully closed). Fit the key to the oil-pump drive shaft and lower the shaft down the bush, making sure that its bottom tongue engages the oil-pump rotor shaft slot. Then rotate the shaft so that the key is facing outwards at right angles to the centre-line of the cylinder block. Now lower the gear on to the shaft; it will turn as it engages the camshaft gear, and when finally down on the bush, the gear should be positioned with its drive slots as shown on **FIG 1:48** on 'Spitfire' engines, and **FIG 1:49** on six-cylinder engines. When this position has been secured, fit the pedestal along with packing washers of the required thickness to give correct end-float.

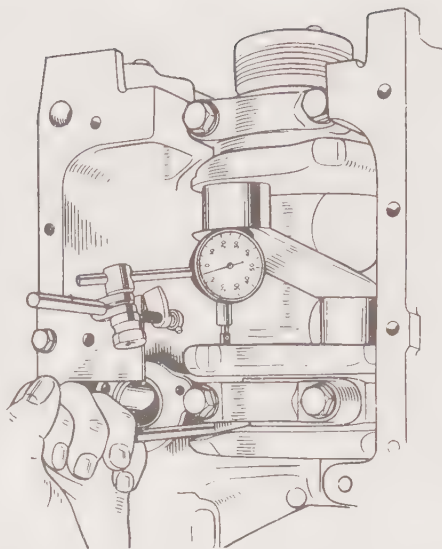


Fig 1:33 Checking crankshaft end-float by levering with screwdriver.

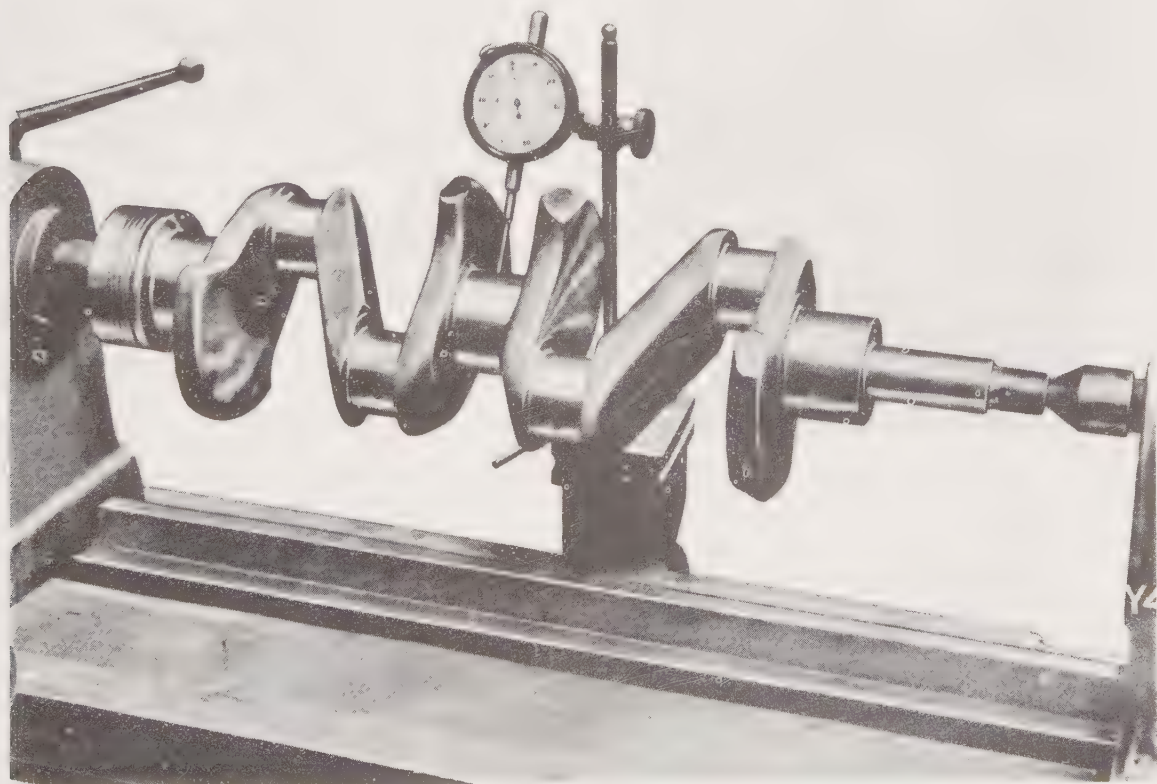


Fig 1:34 Measuring crankshaft run-out by means of dial gauge.

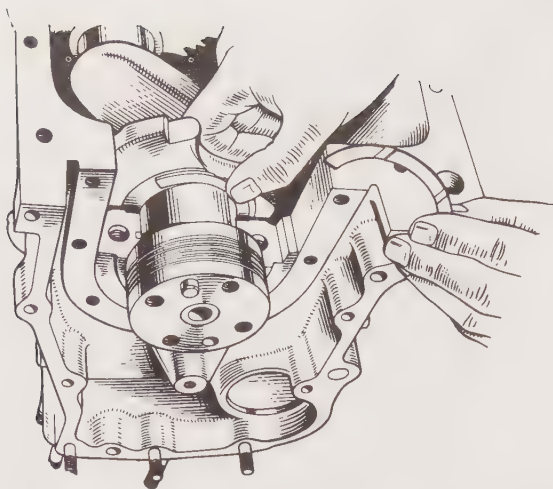


Fig 1 : 35 Fitting thrust washers to rear main bearing journal.

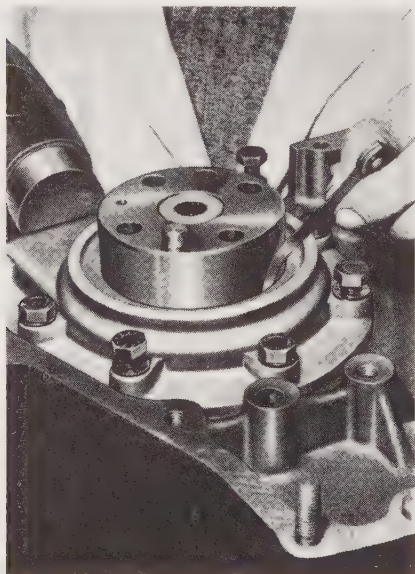


Fig 1 : 36 Adjustment of housing clearance at rear of crankshaft.

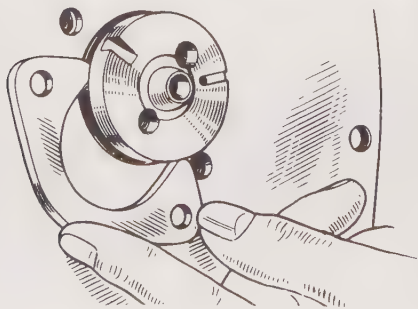


Fig 1 : 37 Fitting thrust plate behind camshaft boss.

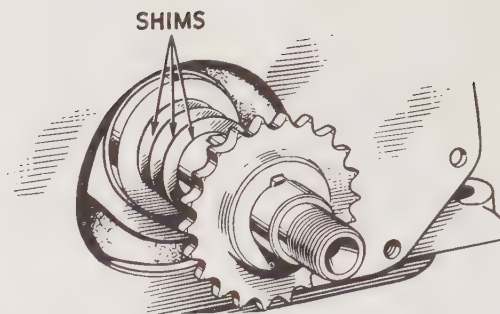


Fig 1 : 38 Shim adjustment for crankshaft sprocket, to ensure correct chain alignment.

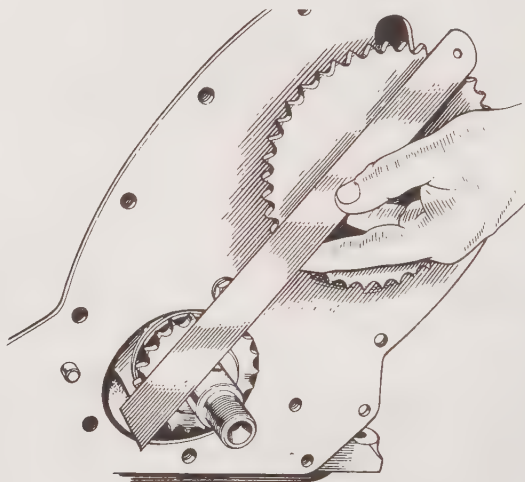


Fig 1 : 39 Checking sprocket alignment by means of straight-edge.

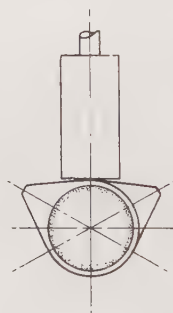


Fig 1 : 40 Position of inlet and exhaust cams for one cylinder, at point of balance.

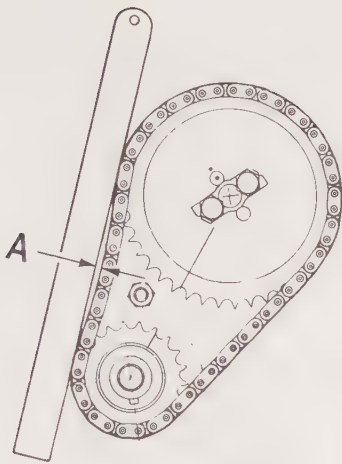


Fig 1 : 41 Method of gauging wear on timing chain. Dimension A should not exceed 0.25 in (6 mm).

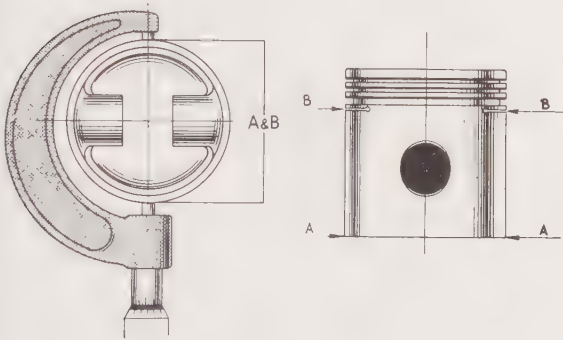


Fig 1 : 42 Method of measuring piston (refer to text for lettering references).

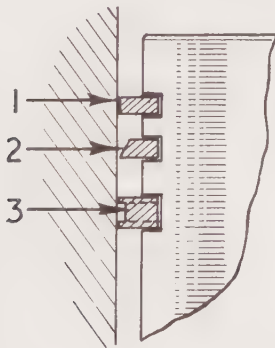


Fig 1 : 43 Sections of piston rings, and positions.

Key to Fig 1 : 43 1 Parallel ring (top). 2 Taper ring (middle). 3 Oil control ring (bottom).

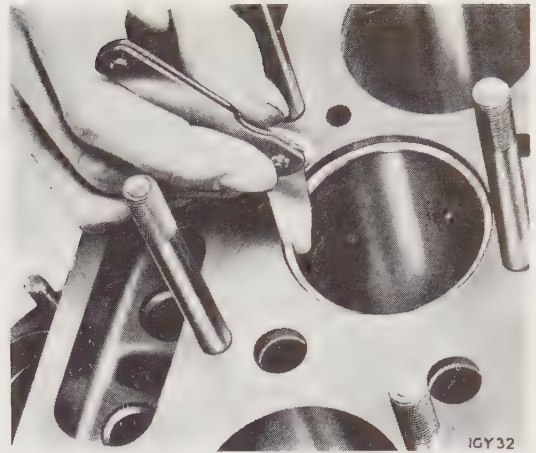


Fig 1 : 44 Measurement of piston ring gap by feeler gauge.



Fig 1 : 45 Piston ring squeezer in use to facilitate piston entry into bore.

1:21 Cylinder head assembly

The cylinder head component can be assembled to the head after the latter has been dealt with as required, i.e. decarbonized, rectified or modified. The valves may be ground in as necessary, but if this does not meet the essential requirement of gas-tightness, any refacing or seat recutting must be entrusted to an agent.

Valve guide wear can be gauged by fitting a new valve to the guide, lifting it 0.125 in (3.2 mm) from its seat, and rocking the valve sideways, when movement of the head across the seat should not exceed 0.020 in (0.5 mm). Worn guides may be removed and new ones fitted by use of a suitable tool as shown on **FIG 1 : 50**, which is Churchill tool No. S 60A-6. Alternatively an extractor can be made up from a long threaded rod with washers, nuts and tubular distance-pieces. Note the dimension for protrusion of the guide above the rocker face; this is important, as it determines the amount by which the guide enters the valve throat.

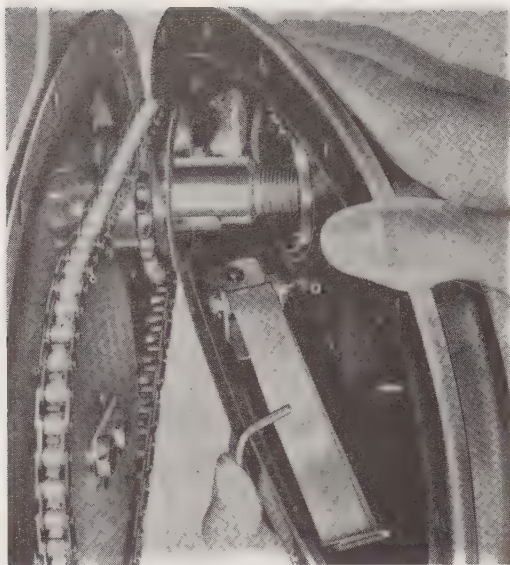


Fig 1:46 Replacement of timing chain cover; note tensioner blade held back clear of chain.

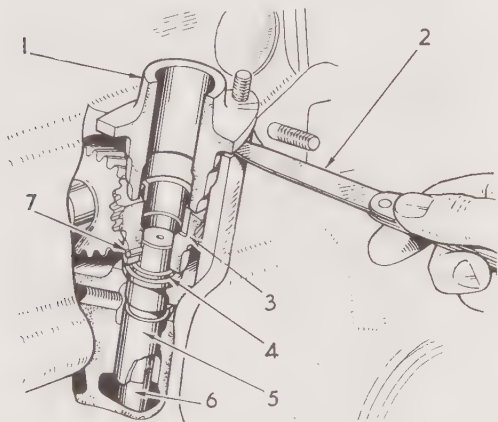


Fig 1:47 Use of intrusive washer to ascertain correct end-float of distributor drive.

Key to Fig 1:47 1 Distributor. 2 Feeler gauge. 3 Drive gear. 4 Intrusive washer. 5 Lower bush. 6 Oil pump drive. 7 Cross-pin.

Guides must never be fitted or removed by hammering or drifting, as this will damage both the guide and the head casting. Also, valves should not be refitted if the stems are unduly worn, or distorted in any way.

The valve springs may be checked against the data given in the Appendix. **Fig 1:51**, shows a spring scale device which is used for ascertaining the spring load at any specified length.

If the valves have been ground, all traces of grinding paste must be washed from the cylinder head and ports. Lubricate the valve stem before assembly, and fit the

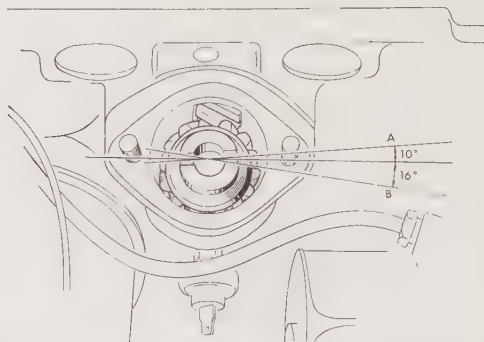


Fig 1:48 Position of distributor drive slot at tdc of No. 1 piston, 'Spitfire' engine, using angle B.

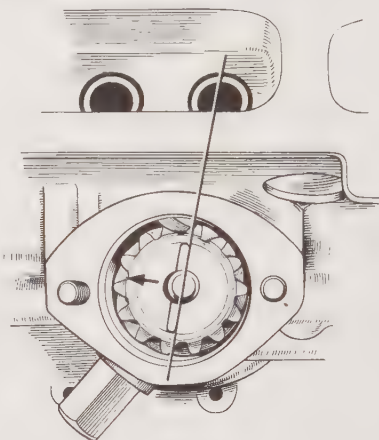


Fig 1:49 Position of distributor drive slot at tdc of No. 1 piston, 6-cylinder engines.

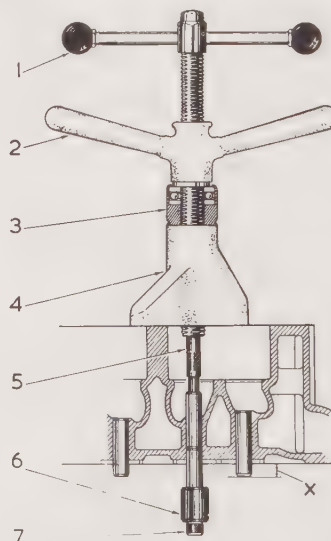


Fig 1:50 Replacing worn valve guide by means of special tool.

Key to Fig 1:50 1 Handle. 2 Second handle. 3 Thrust block. 4 Body. 5 Adaptor. 6 Distance collar. 7 Knurled nut. Dimensions X=0.749–0.751 in.

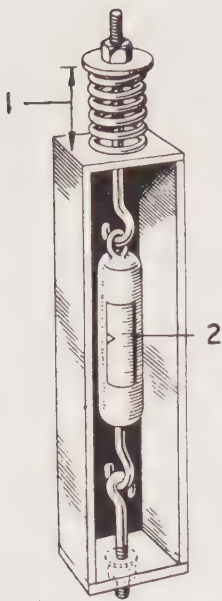


Fig 1:51 Spring balance for measuring load of valve springs.

Key to Fig 1:51 1 Valve spring adjusted to fitted length dimension. 2 Balance indicating fitted load.

collars and springs as in the order of removal (**FIG 1:29**). Using the spring compressor to hold the components in place, fit the collets carefully to the stem. The compressor is then slowly released, noting that the collets must wedge properly, and that the top collar is perfectly level. On engines without loose collets, the offset hole in the collar is pressed down over the stem in a similar manner, and then moved sideways so as to be absolutely central to the valve stem, the compressor then being released. After all the valves have been refitted, test each one for operation by pressing down with a vertical push on the end of the stem. If an oil leak has occurred at any time at the short tubes which enclose the upper ends of the push-rods on early engines, the tube-ends can be swaged into their countersunk holes by using a pair of mandrels dimensioned as shown on **FIG 1:52**. These tubes are superseded by tunnels cast in the head, on all later engines.

1:22 Head replacement

The cylinder head gasket must next be evenly coated with a good jointing compound, and carefully fitted over the studs and on to the head face. Place the head over the studs, and allow it to drop gently and evenly on to the gasket. Tighten the holding-down nuts until they just nip, and then finally tighten in the correct order 'inwards to outwards' as shown on **FIGS 1:26 to 1:28** to a torque reading of 42–46 lb/ft. Go over the sequence several times so that tightening is even all the way. Note also that the engine lifting eye is fitted on one stud, and on some types there may be an abutment bracket on another stud. The

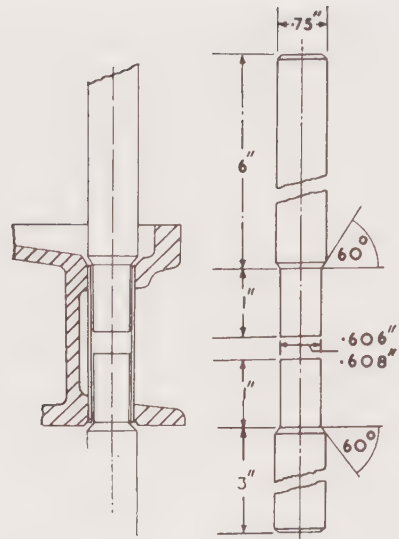


Fig 1:52 Mandrels for swaging push-rod tube ends to remedy oil leaks on early engines.

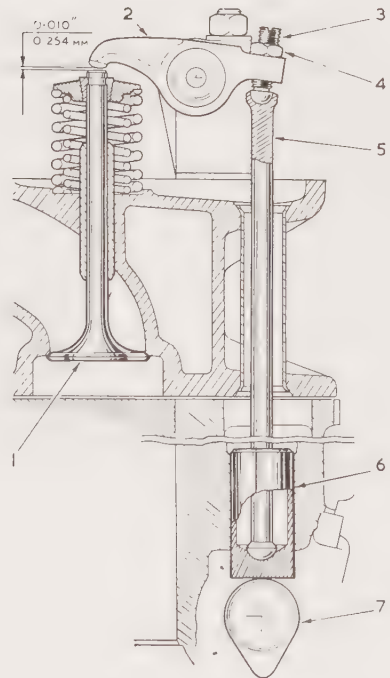


Fig 1:53 Valve-train and working clearance.

Key to Fig 1:53 1 Valve. 2 Rocker. 3 Adjustment screw. 4 Locknut. 5 Push-rod. 6 Tappet. 7 Cam.

rocker-shaft may next be reassembled, after thoroughly cleaning the shaft both inside and out, as well as all components. Refer to **FIG 1:25** for correct positioning of the parts along the shaft. The rocker adjusting screws should be slackened off. When fitting the shaft end-cap, a new Mills drive-pin must be used. Check that the tappets are positioned correctly and insert the push-rods, noting that their lower ends register properly in the tappets. Then fit the rocker-shaft over its studs, taking care that the push-rods engage the ball-ended adjusting screws. Lower the pedestals on the studs, fit the nuts and tighten them gradually to take up the uneven valve spring pressure. Finally, tighten to a torque of 24–26 lb/ft.

The rocker clearance must next be adjusted, in each case with the tappet on the back or base circle of the cam. To obtain this position, the crankshaft must be turned until the valve is at full lift; the crankshaft is then rotated through a full revolution to ensure that the tappet and push-rod are at their lowest position. The clearance must then be adjusted by feeler gauge to the dimension (cold) indicated on **FIG 1:53**.

A well-known method of obtaining the correct cam position is to adjust certain closed valves when others are fully open, the engine being rotated with the plugs removed, by pulling on the fan blades, if the work is being done with the power unit installed. Assuming the valves are numbered in sequence from the front of the engine, turn the crankshaft until the valve numbered on the left, in the following tables, is fully open.

Four-cylinder engines

Valves fully open	Valves closed (to adjust)
Nos. 1 and 3	Nos. 6 and 8
2 and 5	7 and 4
6 and 8	3 and 1
4 and 7	2 and 5

Six-cylinder engines

Valves fully open	Valves closed (to adjust)
Nos. 1 and 3	Nos. 10 and 12
8 and 11	2 and 5
4 and 6	7 and 9
10 and 12	1 and 3
2 and 5	8 and 11
7 and 9	4 and 6

It is worthwhile checking the valve clearance after a short period of running, and after the parts have had a chance to bed down. If extra care is taken on this point, consistency of clearance throughout the eight or twelve valves, can mean quite a lot in terms of engine smoothness and quiet running.

1:23 Ignition timing

The ignition distributor is next refitted by lowering it into the drive pedestal and engaging the driving dog on the shaft end with the slot at the top of the skew gear; then secure the clamp plate to the pedestal. Turn the crankshaft so that No. 1 cylinder is on tdc of the firing stroke (both valves closed). The distributor rotor arm should then be in a position where it lines-up approximately with the HT contact for No. 1 cylinder. On 'Spitfire' engines having a vernier adjustment screw on the distributor this must be

rotated until the distributor is fully retarded. Then turn the distributor body in the pedestal until the contact-breaker points are just about to open, and tighten the clamp. The vernier screw is then adjusted to give the required static setting, noting that one click of the milled nut is equal to one crankshaft degree, or four degrees per one division on the main scale. The settings are as follows:

- 1147 cc 'Spitfire' Mk. I. Setting 13 deg before tdc, or 3.25 divisions.
- 1147 cc 'Spitfire' Mk. II. Setting 17 deg before tdc, or 4.25 divisions.
- 1296 cc 'Spitfire' Mk. III. Setting 6 deg before tdc, or 1.5 divisions.
- 1596 cc engine. Setting 10 deg before tdc, or 2.5 divisions.
- 1998 cc engine. Twin carburettor. Setting 12 deg before tdc, or 3 divisions.

If there is no vernier adjustment, the distributor must be set so that the contact points are just opening as already described, and the final adjustment obtained either by stroboscopic equipment or by road-test as detailed in Chapter 3. In any case, it is essential to finalise the setting by road performance regardless of the type of distributor, since any static setting must be regarded as nominal, and will vary according to general engine condition, amount of carbon deposit present, and variations in fuel rating. It is however essential that the timing is not given an over-advanced setting in the static position.

1:24 Manifolds

When refitting the manifold system after attention to the carburettors as detailed in Chapter 2, the gasket should be coated on both sides with a good heat-resistant jointing compound, and the nuts tightened evenly to a torque of 24–26 lb/ft. The fuel pump is replaced using a new packing if necessary, also the oil-pressure switch, water outlet casting, and thermostat. After fitting the generator, the belt should be tensioned as described in Chapter 4, which also deals with overhaul of the water pump and cooling system.

When refitting the clutch pressure unit and driving plate to the flywheel, it is necessary to employ a centralising mandrel to ensure that the plate is properly in line with the spigot bearing at the flywheel centre; this ensures that the gearbox input shaft can be inserted without damage or strain. With such a mandrel in position through the pressure unit and plate centre, the former may be positioned on the flywheel face in the same relationship as when removed, the bolts inserted and tightened in a diametrical sequence to a torque of 18–20 lb/ft.

1:25 Fault diagnosis

(a) Engine will not start

- 1 Defective coil
- 2 Faulty distributor capacitor (condenser)
- 3 Dirty, pitted or incorrectly set contact breaker points
- 4 Ignition wires loose or insulation faulty
- 5 Water on sparking plug leads
- 6 Corrosion of battery terminals or battery discharged
- 7 Faulty or jammed starter
- 8 Sparking plug leads wrongly connected
- 9 Vapour lock in fuel pipes
- 10 Defective fuel pump
- 11 Overchoking

- 12 Underchoking
- 13 Blocked petrol filter or carburettor jets
- 14 Leaking valves
- 15 Sticking valves
- 16 Valve timing incorrect
- 17 Ignition timing incorrect

(b) Engine stalls

Check 1, 2, 3, 4, 10, 11, 12, 13, 14 and 15 in (a)

- 1 Sparking plugs defective or gaps incorrect
- 2 Retarded ignition
- 3 Mixture too weak
- 4 Water in fuel system
- 5 Petrol tank vent blocked
- 6 Incorrect valve clearance

(c) Engine idles badly

Check 1 and 6 in (b)

- 1 Air leak at manifold joints
- 2 Slow-running jet blocked or out of adjustment
- 3 Air leak in carburettor
- 4 Over-rich mixture
- 5 Worn piston rings
- 6 Worn valve stems or guides
- 7 Weak exhaust valve springs

(d) Engine misfires

Check 1, 2, 3, 4, 5, 8, 10, 13, 14, 15, 16, 17 in (a); 1, 2, 3 and 6 in (b)

- 1 Weak or broken valve springs

(e) Engine overheats (see Chapter 4)

(f) Compression below normal (or varying between cylinders)

Check 14 and 15 in (a); 5 and 6 in (c); and 1 in (d)

- 1 Worn piston ring grooves
- 2 Scored or worn cylinder bores

(g) Engine lacks power

Check 3, 10, 11, 13, 14, 15, 16, and 17 in (a); 1, 2, 3 and 6 in (b); 5 and 6 in (c); and 1 in (d). Also check (e) and (f)

- 1 Leaking joint washers
- 2 Fouled sparking plugs
- 3 Automatic advance not operating

(h) Burnt valves or seats

Check 14 and 15 in (a); 6 in (b); and 1 in (d). Also check (e)

- 1 Excessive carbon deposit around valve seat and head

(j) Sticking valves

Check 1 in (d)

- 1 Bent valve stem
- 2 Scored valve stem or guide
- 3 Incorrect valve clearance

(k) Excessive cylinder wear

Check 11 in (a) and see Chapter 4

- 1 Lack of oil
- 2 Dirty oil
- 3 Piston rings gummed up or broken
- 4 Badly fitting piston rings
- 5 Connecting rods bent

(l) Excessive oil consumption

Check 5 and 6 in (c) and check (k)

- 1 Ring gaps too wide
- 2 Oil return holes in piston choked with carbon
- 3 Scored cylinders
- 4 Oil level too high
- 5 External oil leaks
- 6 Ineffective valve stem oil seals

(m) Crankshaft and connecting rod bearing failure

Check 1 in (k)

- 1 Restricted oilways
- 2 Worn journals or crank pins
- 3 Loose bearing caps
- 4 Extremely low oil pressure
- 5 Bent connecting rod

(n) Internal water leakage (see Chapter 4)

(o) Poor circulation (see Chapter 4)

(p) Corrosion (see Chapter 4)

(q) High fuel consumption (see Chapter 2)

(r) Engine vibration

- 1 Loose generator bolts
- 2 Fan blades out of balance
- 3 Defective engine mountings

CHAPTER 2

CARBURETTERS AND FUEL SYSTEM

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2:5 Solex Carburetter	2:13 Stromberg carburetter	2:21 Air cleaner
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2:7 Synchronization	2:15 Normal running	2:23 Fault diagnosis
2:8 Dismantling	2:16 Adjustments	

On all engines, the fuel pump is of the mechanical diaphragm type, mounted on the engine crankcase and operated by an eccentric on the camshaft. The pump fitted to six-cylinder engines is slightly larger than that used on the 'Spitfire' unit, but apart from the arrangement of the filter, there is little difference in the construction.

The pump is self-contained and attached by means of a flange and studs to a facing on the crankcase side, as shown on **FIG 2:1**, in which position the diaphragm operating arm engages the camshaft eccentric as shown on the sectional view, **FIG 2:2**. The pump diaphragm is pulled downwards when the rocker arm is pushed forwards by the eccentric, and this movement fills the pump chamber with fuel. The return or pumping stroke is performed by a spring; thus the delivery pressure is determined solely by the spring loading, and the diaphragm stroke by the amount of fuel in the pump chamber. If the latter is full, the rocker arm reciprocates idly until fuel is used. In order to allow for this feature, the arm is formed in two pieces united at the fulcrum. The part contacting the eccentric has an abutment which moves the second part coupled to the pull-rod of the diaphragm. The arm is held in constant

contact with the eccentric by a light compression spring, to ensure quiet operation.

The fuel inlet and delivery valves are of light spring-loaded type as shown in the component illustrations. Minor changes in manufacture are likely to take place over a considerable period of production, and it may be found that valve construction in particular has undergone revision. However if attention is needed and there is any doubt about the method of retention of these small components, it is best to change the complete sub-assembly for a serviced unit. Fuel is drawn in through a gauze filter screen which in the case of the smaller pump is under a metal dome cover, as shown on **FIG 2:3**. The larger pump used on six-cylinder engines has a transparent bowl over the screen, as on **FIG 2:4**.

2:1 Pump maintenance

Normal maintenance consists of removing the filter cover and examining the gauze screen. If necessary the latter should be washed in petrol, but the precise mileage at which this is necessary will vary according to the

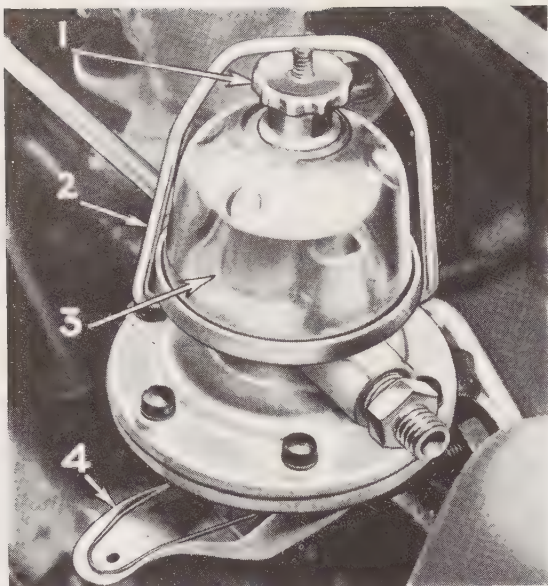


Fig 2:1 Fuel pump in position on 6-cylinder engine.

Key to Fig 2:1 1 Clamp screw. 2 Clamp. 3 Bowl. 4 Priming lever.

cleanliness of the fuel. Cleaning should not be called for at less than 6000-mile intervals in normal conditions.

The metal reinforcing plate on the filter of the small pump shown on **FIG 2:3** should face upwards, while on the other type the filter is fitted so that its rim locates on the casting spigot. Before refitting the cover, or the transparent sediment bowl, these items should be cleaned also, and a new gasket fitted if this has become hardened or broken. It is most important that there is no leakage of air at this point, as any intake will reduce the suction effect and in extreme cases will put the pump out of action.

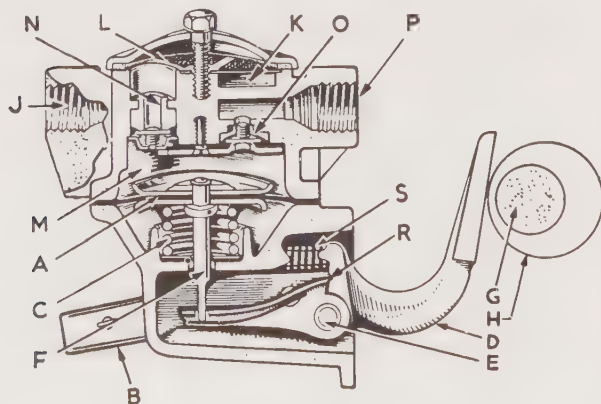


Fig 2:2 Section of small type fuel pump.

Key to Fig 2:2 A Diaphragm. B Priming lever. C Diaphragm spring. D Rocker arm. E Pivot. F Pull-rod. G Camshaft. H Eccentric. J Fuel inlet. K Well. L Filter gauge. M Pumping chamber. N Inlet valve. O Delivery valve. P Fuel outlet. R Rocker abutment joint. S Rocker return spring.

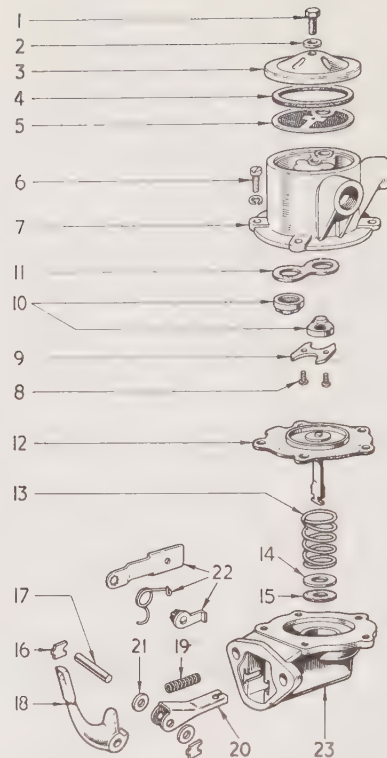


Fig 2:3 Components of fuel pump, small type for 4-cylinder engines.

Key to Fig 2:3 1 Retaining screw. 2 Washer. 3 Cover. 4 Joint. 5 Gauze. 6 Screw. 7 Body. 8 Screws. 9 Retainer. 10 Valves. 11 Upper retainer. 12 Diaphragm assembly. 13 Spring. 14 Washer. 15 Washer. 16 Retainer. 17 Spindle. 18 Operating lever. 19 Return spring. 20 Operating fork. 21 Distance washer. 22 Priming lever assembly. 23 Lower body.

2:2 Pump test

To test the pump, the delivery pipe is disconnected at the carburetter end, and its outlet led into a jar. When the engine is rotated by the starter, a good spurt of fuel should be obtained at each stroke of the pump, or camshaft revolution. There should be no hesitancy in delivery, nor air bubbles present.

To test the suction it is necessary to use a vacuum gauge connected to the pump inlet union, in place of the pipe from the tank. The engine can then be run under power, on the carburetter contents, at idling speed. A vacuum reading of 8.5 in (21.5 cm) of mercury should be obtained. The gauge should also take at least a minute to drop to zero, otherwise a faulty diaphragm must be suspected, or air-leaks elsewhere.

As the delivery pressure is dependent on the spring, it should not vary unless the diaphragm is faulty; leaks are of course generally obvious by the presence of petrol on the outside of the pump. If it is desired to take a pressure reading, a suitable gauge is connected to the delivery union. With the engine running as before (on the carburetter contents) the maximum pressure should be 2 lb

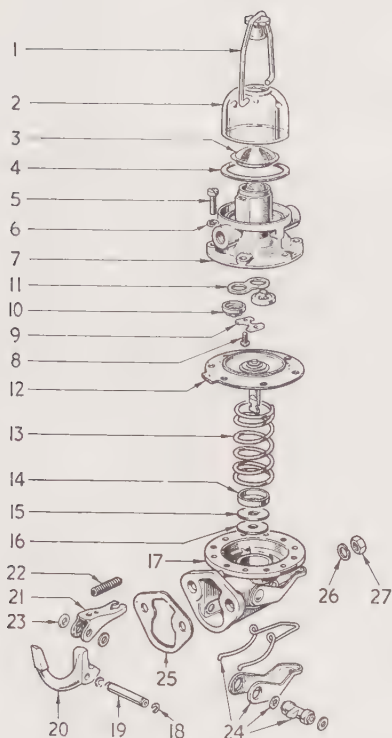


Fig 2:4 Components of fuel pump, larger type for 6-cylinder engines.

Key to Fig 2:4 1 Stirrup. 2 Sediment bowl. 3 Filter gauze. 4 Joint. 5 Screw. 6 Spring washer. 7 Body. 8 Screw. 9 Retainer. 10 Valves. 11 Upper retainer. 12 Diaphragm assembly. 13 Spring. 14 Cup. 15 Washer. 16 Washer. 17 Lower body. 18 Circlip. 19 Spindle. 20 Operating lever. 21 Operating fork. 22 Return spring. 23 Distance washer. 24 Priming lever assembly. 25 Gasket. 26 Spring washer. 27 Nut.

and minimum 1.25 lb. Too low a pressure will starve the carburetter, while if too high flooding will be caused, leading to faulty mixture and highly erratic engine performance.

To overhaul the pump, assuming it has been removed from the engine, first remove the filter cover or sediment bowl, and the gauze screen. Then mark the upper and lower bodies at the diaphragm flange, adjacent to the smaller tab on the diaphragm, so that reassembly will be correct. Remove the screws and spring washers at the flange, and very carefully separate the joint. Ease the diaphragm away from its contact with the metal face, avoiding damage to the flexible material. The diaphragm pull-rod is fixed permanently to the centre of the diaphragm, this item being supplied as a complete unit. The rod is freed from the rocker arm by turning the diaphragm about a quarter-turn, in either direction relative to the lower body. After detaching, remove the spring, seal retainer and rubber seal.

2:3 Pump valves

As already stated, the method of valve construction may vary. In typical pumps however, the valves are held in

the top body by a plate secured by two screws. They are interchangeable unit assemblies complete with their springs and seats, and can be taken out after removal of the two screws in the plate. Note that there is a figure-8 gasket interposed between the valves and body.

The rocker arm assembly in the lower body seldom requires attention, but if necessary may be dismantled by holding the rocker arm in a vice, leaving a gap between the vice jaws and the body casting. Two flat bars of suitable size are then inserted one on either side of the rocker arm between the vice and body. By applying careful and equal leverage, the body will be urged away from the fulcrum pin, which will emerge complete with the rocker arm and pin retainers, all these of course remaining on the rocker arm, which is in the vice. Be careful, however, not to let the body drop on the floor as it comes away; also, do not use as levers, any makeshift pieces of metal which may damage the body.

It is most unlikely that the hand-priming lever will need attention, but if it must be replaced, a new assembly should be used. The old one is removed by filing off the riveted head of the pivot pin, and drifting it out of the body along with its inner lever.

All components must be cleaned carefully and any defective ones replaced. The pad face of the rocker arm which contacts the cam should be examined for wear; this should not exceed a depth of 0.010 in. If necessary, the engine mounting flange and the diaphragm flanges may be lapped to obtain precise flatness, but this is unlikely to be required unless distortion has taken place as a result of mishandling.

2:4 Reassembly

If the hand-priming lever has been removed, this must first be replaced in the lower body and its pin riveted firmly; it is assembled, with the return spring, from the inside of the body. The rocker arm is next positioned with its boss between the flanges of the diaphragm link-piece, noting that the centre web of the latter and the spring seat on the rocker are uppermost (this ensures the correct abutting action when pumping). A washer is now fitted next to the link on each side and the whole inserted into the lower body casting.

Put the compression spring for the rocker return into position, locating it between the registers at each end. Fit two new pin retainers into the body, tapping them home while ensuring that the pivot pin is right back in its location;peen over the casting to secure the retainers in position. Note that service replacement retainers are copper-coloured for identification, being slightly shorter than the standard type to allow for re-riveting of the casting. If all is satisfactory, the rocker arm will operate against its spring; also when the diaphragm-end is held down (as when the carburetter is full) the other end of the arm assembly should be free to move up and down without transmitting any motion.

The diaphragm assembly must be examined very carefully for defects; if at all doubtful it must be replaced. To refit, the spring, oil-seal washer, and seal are first threaded over the pull-rod. The end of the pull-rod is next inserted into the end of the link and it is then necessary to press down on the diaphragm centre, and at the same time turn it through 90 deg. This action will engage the grooves between the link and pull-rod. The holes in the diaphragm

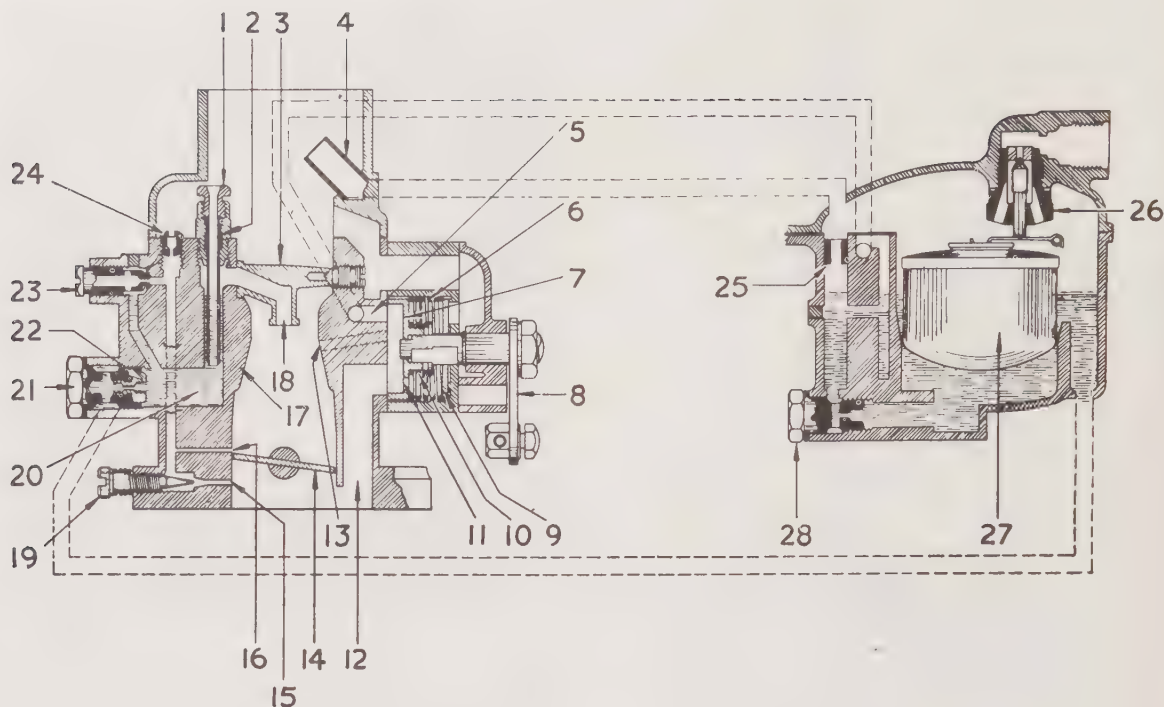


Fig 2:5 Sectional view of Solex carburettor (for description only).

Key to Fig 2:5 1 Air correction jet. 2 Emulsion tube. 3 Discharge nozzle. 4 Float chamber vent. 5 Starter petrol channel. 6 Starter air valve spring. 7 Starter valve. 8 Starter lever. 9 Starter air valve. 10 Starter valve spring. 11 Starter air jet. 12 Starter outlet channel. 13 Quick drive away channel. 14 Throttle. 15 Idling orifice. 16 By-pass orifice. 17 Choke tube. 18 Spraying orifice. 19 Volume control screw. 20 Reserve well. 21 Main jet holder. 22 Main jet. 23 Pilot jet. 24 Pilot jet air bleed. 25 Starter air bleed. 26 Needle valve. 27 Float. 28 Starter pilot jet.

edge should also match up with the holes on the body flange. The upper body casting is next positioned over the diaphragm so that the mark on the flange aligns with that on the lower body. Insert the screws around the flange edge to light finger-tightness. Work the rocker arm by hand several times to allow the diaphragm to centralise itself. Finally, hold the arm fully 'in' so that the diaphragm is right down on the suction stroke, and tighten the flange screws quite evenly.

It is quite unnecessary and wrong to use jointing compound on the diaphragm-edge to ensure a tight joint, but strict cleanliness must be observed both on the flange faces and the diaphragm itself.

The pump can next be held normally, and the valve assemblies refitted, first ensuring that the figure-8 gasket is in position. See that the valve assemblies are the correct way up, otherwise they will not function. The retainer plate is then refitted. The filter screen may now be replaced along with the top cover.

When refitting the fuel inlet and delivery pipes, make sure these are not distorted and are free from leaks.

To ensure correct pump action, the thickness of the gasket at the pump-to-crankcase flange mounting must not be varied.

2:5 Solex carburettor

Twin carburettor installations of various types and makes are fitted to the range of engines covered, and it is important before commencing operations of any kind, to ensure that the correct instructions are carefully followed and full use made of the illustrations. Dealing first with the 1598 cc Vitesse engine, the earlier types up to engine No. HB6798 employ a pair of Solex semi-down-draught carburettors, each having a separate starting device mounted on the main body. The action can be followed from FIG 2:5 (which shows a normal down-draught type but is fully explanatory), in conjunction with the following explanation.

For starting from cold, operation of the choke control moves lever 8 to rotate disc valve 7. This aligns the slot in the disc with a channel 5. The engine suction then draws fuel from the starter jet 28 and this is emulsified by air from the starter air bleed 25. The mixture passes along 5 across the valve slot 7 and into the engine through channel 12. When the engine fires, there is increased suction on the intake throughway, and this lifts the air valve 9 against spring 6. This admits additional air from the intake, past the valve and through passage 11.

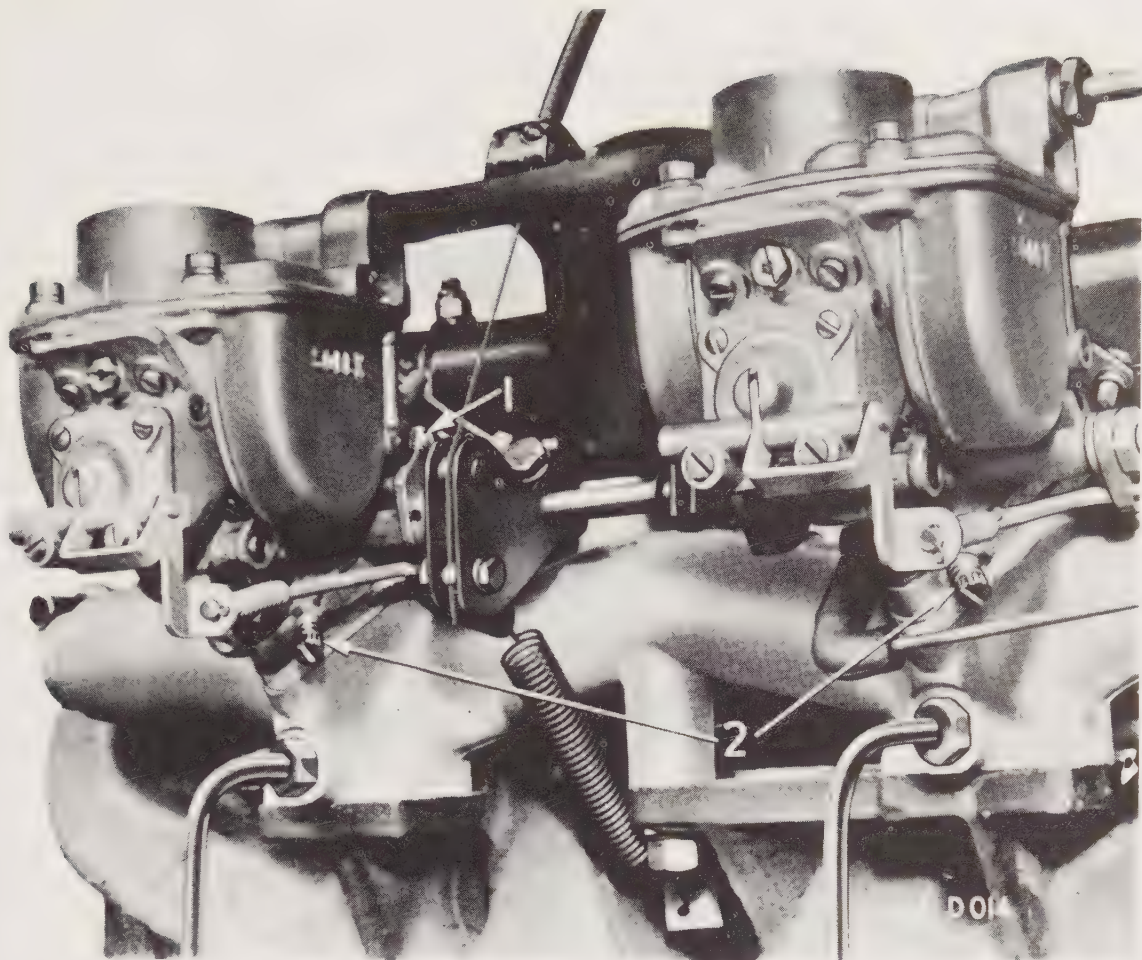


Fig 2 : 6 Twin Solex type B32 P1 H carburetters in position on 1600 cc 'Vitesse' engine.

Key to Fig 2 : 6 1 Throttle stop screws. 2 Slow running mixture screws.

After a few seconds running, the control is pushed in for about one-quarter of its travel; this rotates the valve 7 to a position in which the fuel quantity from channel 5 is much reduced, and air is admitted, to the full capacity of the passages 11 from the main air intake via elongated holes in valve 9. More air is also coming in through channel 13, which further restricts the output from channel 5. This is the 'drive-away' position before the engine has warmed up, and is made possible because of the suction acting on 13 when the throttle is opened, so that an additional fuel supply is drawn from 5 to meet power requirements. Simultaneously, the depression acting on 12 continues to draw fuel through from 5, and this combines with air from 11. As the engine warms up, the choke control is moved progressively to 'off'; thus rotating the valve 7 and gradually reducing the flow from 5 and 9 until they are completely blanked off. The starter section is then out of action.

The idling mixture is obtained from the idling orifice 15 which it will be seen is on the engine side of the throttle valve. However, as the latter is opened, the bypass orifice 16 begins to function, but only until the throttle is opened sufficiently to create a depression on the main spraying orifice 18. In this way, a smooth transfer takes place between the idling circuit and the main system.

Fuel is supplied from the reserve well 20, being metered by the pilot jet 23, and pre-emulsified by the air-bleed 24. Additional air for idling comes in through 16, the volume of this being controllable by adjusting the screw 19. After leaving the idling orifice 15 the mixture is further emulsified by the air passing the edges of the throttle butterfly, which is held slightly open to a degree determined by adjustment of the slow-running screw.

As the throttle is opened, the suction is directed at the drilling 16 which discharges sufficient fuel to meet requirements until the throttle is far enough open for the main

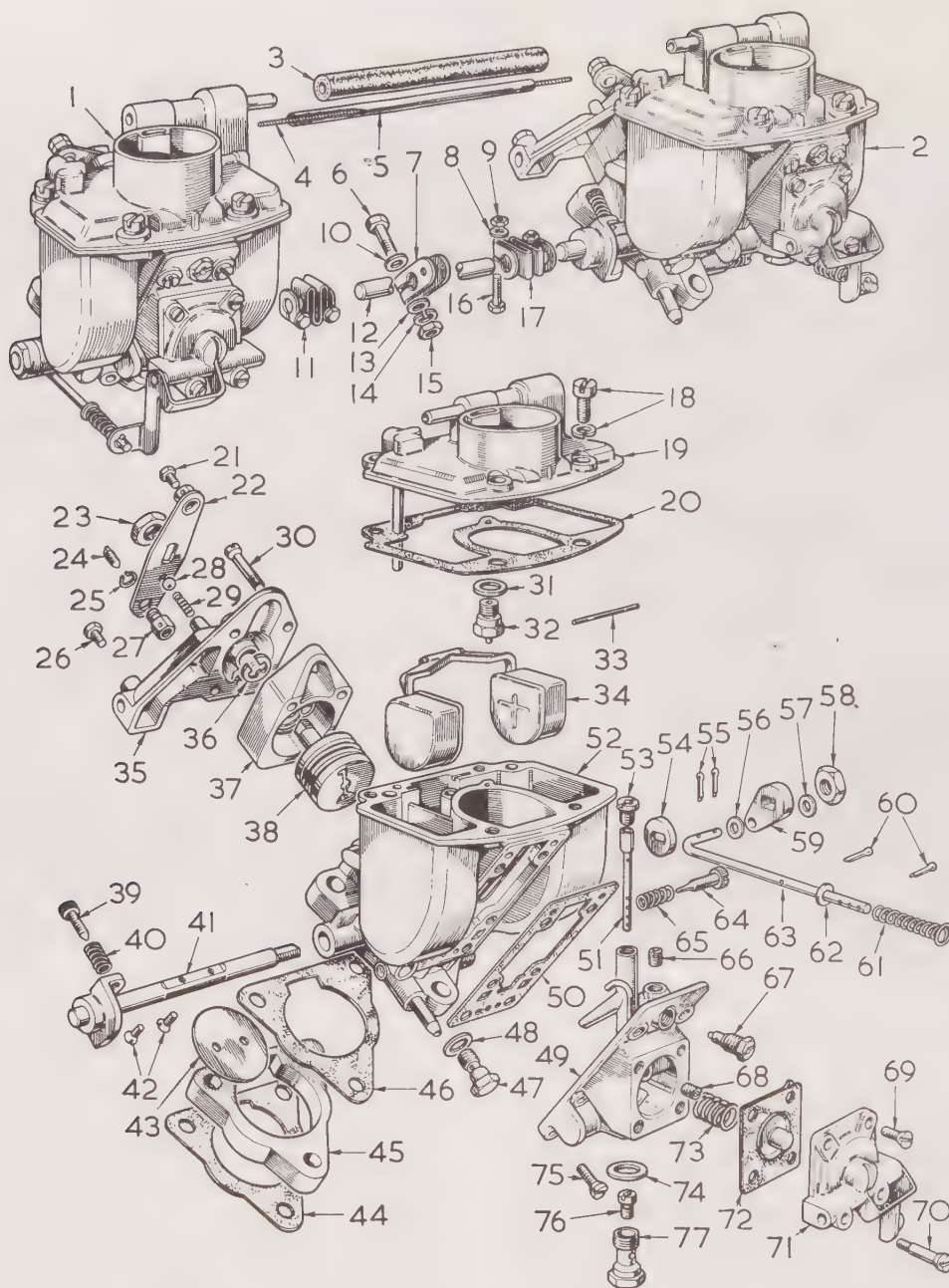


Fig 2:7 Components of Solex type B32 P1 H twin carburettor installation.

Key to Fig 2:7 1 Rear carburettor. 2 Front carburettor. 3 Fuel hose. 4 Choke cable—inner. 5 Choke cable—outer. 6 Pinch bolt. 7 Accelerator lever. 8 Plain washer. 9 Nut. 10 Plain washer. 11 Coupling assembly. 12 Coupling rod. 13 Spring washer. 14 Plain washer. 15 Nut. 16 Pinch bolt. 17 Spring coupling. 18 Screw and spring washer. 19 Top cover. 20 Gasket. 21 Pinch screw. 22 Lever. 23 Nut. 24 Pinch screw. 25 Circlip. 26 Screw. 27 Nipple. 28 Ball. 29 Spring. 30 Bolt. 31 Fibre washer. 32 Needle valve. 33 Pivot pin. 34 Float assembly. 35 Starter cover. 36 Circlip. 37 Starter body. 38 Disc valve. 39 Stop screw. 40 Spring. 41 Throttle spindle. 42 Screws. 43 Throttle disc. 44 Gasket. 45 Insulation gasket. 46 Gasket. 47 Starter jet. 48 Washer. 49 Jet block assembly. 50 Gasket. 51 Emulsion tube. 52 Carburettor body. 53 Air correction jet. 54 Distance piece. 55 Split-pins. 56 Plain washer. 57 Plain washer. 58 Nut. 59 Lever. 60 Split-pins. 61 Spring. 62 Plain washer. 63 Push-rod. 64 Idling mixture adjusting screw. 65 Spring. 66 Idling mixture air bleed jet. 67 Idling mixture fuel jet. 68 Pump jet. 69 Screw. 70 Screw. 71 Pump cover plate assembly. 72 Pump diaphragm. 73 Spring. 74 Fibre washer. 75 Screw. 76 Main jet. 77 Main jet carrier.

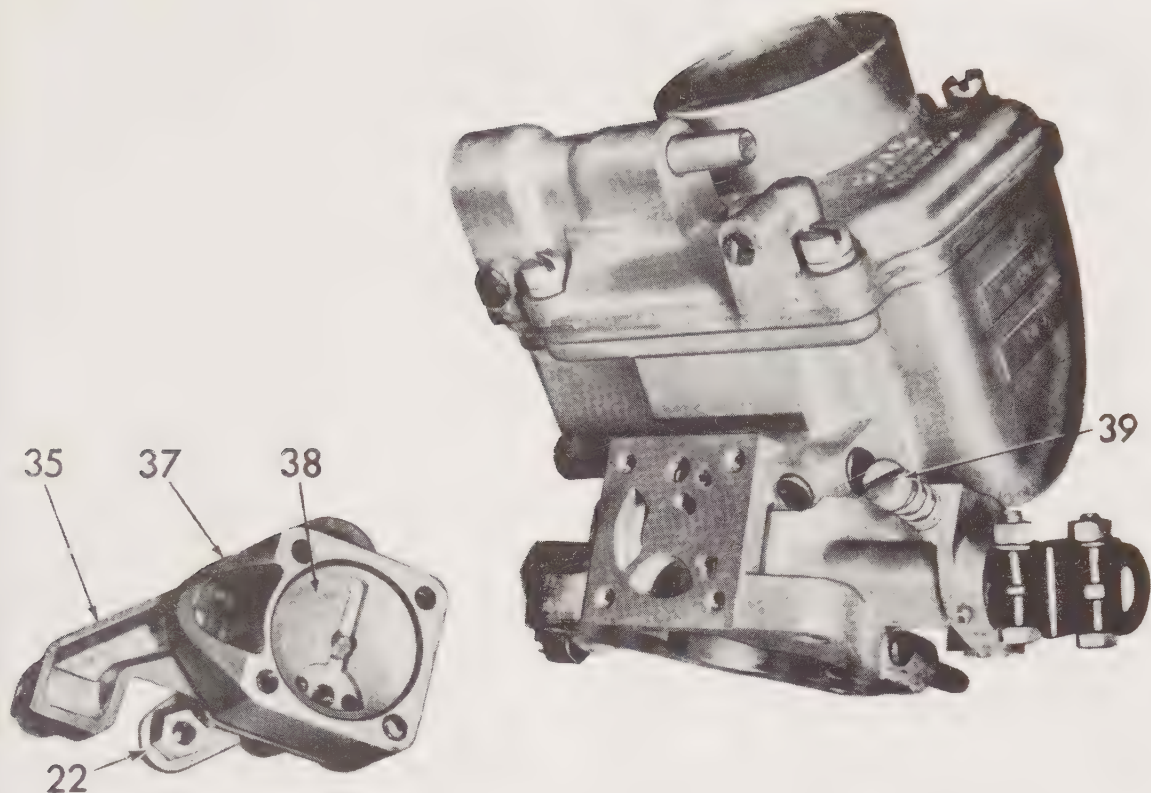


Fig 2:8 Starting device removed from Solex type B32 P1 H carburettor. (For part numbers refer to Fig 2:15.)

spraying system to operate. The air speed through the choke (or venturi) rises as the throttle is further opened; the resultant depression acts on the orifice 18, drawing fuel from the spraying nozzle which is supplied by the main jet 22 through the reserve well 20, where it is emulsified by air entering through the air correction jet 1. The mixture then passes out through the side drillings in the emulsion tube 2. On further increase of engine speed, the large hole in the bottom of the emulsion tube is uncovered. The volume of air is thus increased to balance the fuel output from the main jet 22, the fuel being then emulsified to meet all the requirements of engine load and speed. The fuel level in the float chamber is under the control of float 27, operating the needle valve 26.

The accelerator pump is of the diaphragm type mounted on the side of the carburettor body. On sudden opening of the throttle, the pump ejects fuel through a jet-pipe into the main throughway, providing a temporarily richer mixture for maximum acceleration. It is important not to operate the throttle when the engine is stopped or choked, since liquid fuel will be pumped into the induction pipe, and will make starting difficult.

2:6 Adjustment

It is emphasized that correct idling can only be obtained on an engine which is in good condition throughout. Thus

before any carburettor adjustments are attempted, the ignition system, valve operation, mechanical condition and other relevant items must be in first-class order. As far as the carburettor itself is concerned, wear takes place very slowly in such places as the throttle spindle, but can of course cause serious air-leaks. If such wear is present the carburettor must be exchanged for a service assembly.

Controls must operate without backlash and to the full extent of their travel, and return springs should operate with full tension to effect closure. The volume control screws may become distorted by brutal handling, and if defective must be replaced. Screwed inwards, the idling mixture strength is reduced, while reverse movement enriches the mixture.

The carburettors, type B32 P1 H, fitted to engines up to the serial number stated are shown on FIG 2:6, the components being illustrated on FIG 2:7. It will be noted that twin float chambers are positioned on each side of the main body; the starting device already described, is shown on FIG 2:8.

After considerable road experience, it was decided on later engines to put the accelerator pump out of action, and finally remove it and fit a blanking plate at the pump flange, in the interests of much improved starting with a hot engine. It is thus advised that if carburettors are found with the pumps still operative, they should be modified

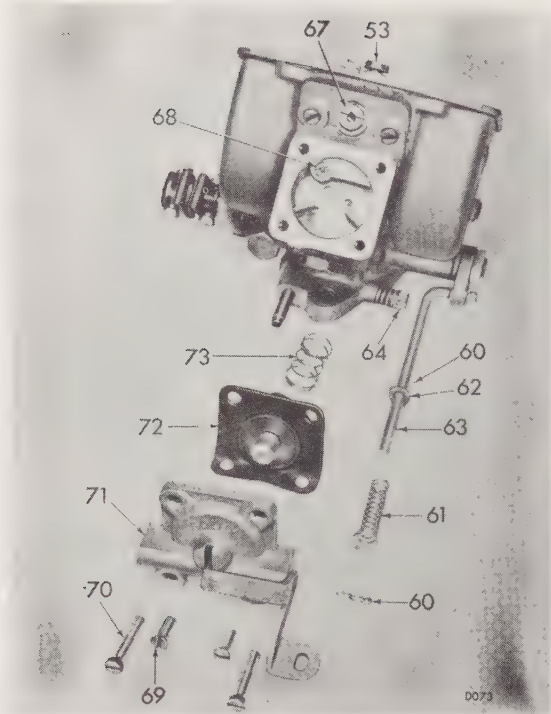


Fig 2:9 Components of accelerator pump, Solex type B32 P1 H carburettor. (For part numbers refer to Fig 2:7.)

as follows. First remove the pump jet and fit a blanking plug, No. 512087. The pump operating rod and arm are detached from the diaphragm cover plate by drifting out the fulcrum pin of the latter. If desired, the pump diaphragm and components shown on **FIG 2:9** can also be removed, and a blanking plate substituted for the diaphragm cover-plate.

To ensure satisfactory idling, it is necessary that both carburetters operate with correct synchronization. The fuel level in the twin float chambers of each carburettor should be checked, by removing the lid from each and

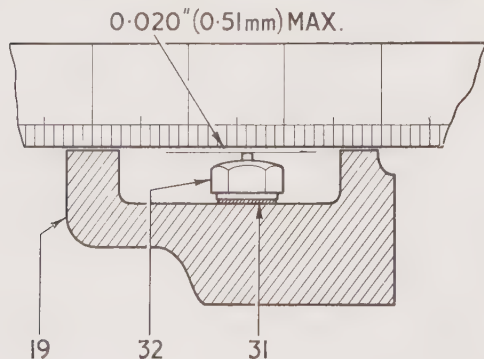


Fig 2:10 Gauging correct needle-valve position in Solex type B32 P1 H carburettor. (For part numbers refer to Fig 2:7.)

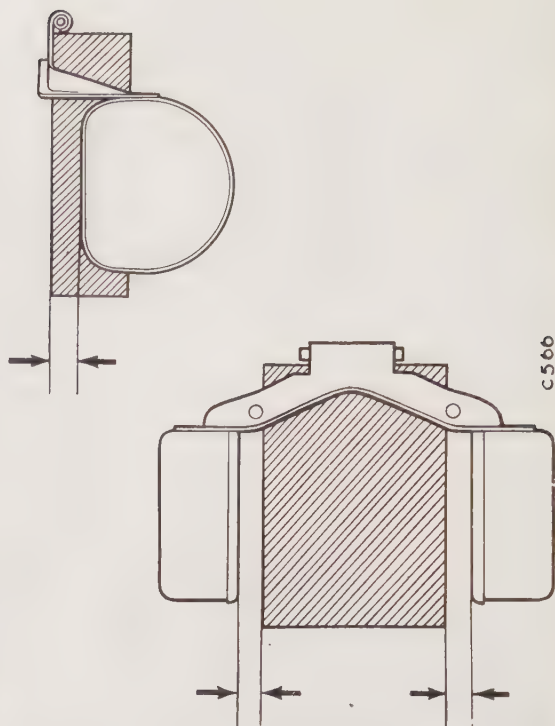


Fig 2:11 Use of wooden block to square-up twin floats, Solex type B32 P1 H carburettor. Arrows indicate parallelism.

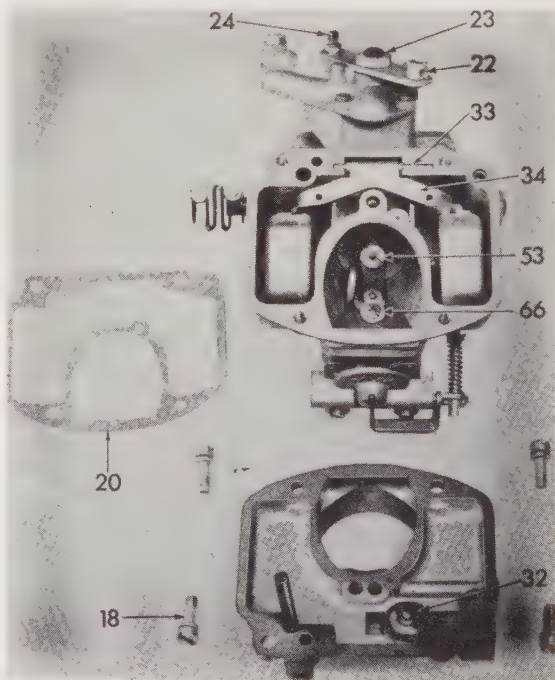


Fig 2:12 Solex type B32 P1 H carburettor with top cover removed. (For part numbers refer to Fig 2:7.)

placing a straight-edge across the machined face with the lid inverted and the needle valve in position. The upper end of the needle should just touch the straight-edge as shown on **FIG 2:10**. If there is a gap of more than 0.020 in (0.51 mm) below the straight-edge, an additional washer, having a thickness of 0.020 in (0.51 mm), must be fitted between the needle valve assembly and the top cover.

The twin floats must next be checked, using a wooden block measuring 2 by 1.5 by 0.5 in (50.8 by 38.1 by 12.7 mm). The float assembly is placed on this as shown on **FIG 2:11**. First ensure that the pivot pin boss lies squarely up to the edge of the block and then set each of the floats so that they are completely symmetrical with the tops and inner faces of the block, and square-on to each face. If properly set, this ensures that each chamber fills to the same level. When assembling, make sure that the floats move quite freely in the chambers.

2:7 Synchronization

Check that all the controls are operating correctly. Run the engine until it is at normal working temperature, slacken the clamp bolt on the interconnection between the two carburetters, and unscrew both throttle adjusting screws so that the throttles are fully closed when under finger pressure on the screw head. Next give each screw one turn clockwise, to obtain an equal amount of opening on the pair of throttles. Turn the idling mixture control screws inwards until they just bottom in the holes (do not use any force) and then unscrew each for one full turn.

The engine is now started, and the slow running (throttle adjustment) screws turned until the speed is about 500 rev/min. The mixture control screws are then turned out say a quarter-turn at a time in sequence, until hunting takes place. Then retract the screws until the idling is again regular. The throttle screws must also be adjusted to obtain a speed of about 600/650 rev/min, this being done as previously, along with any necessary adjustment of the mixture control screws. It is most important to move the adjustments only a little at a time, and there should be no significant difference in the positions of the screws on each carburetter when the correct setting has been obtained. Finally, check that each throttle is closing properly against its adjusting screw, and if all is well, tighten the coupling clamp-bolt.

Never attempt to obtain an excessively low speed, as apart from making irregular running more likely, the engine will tend to stall under negligible extra load; for example when the clutch is withdrawn and there is the thrust bearing friction to contend with.

2:8 Dismantling

If the carburetters require taking down, they must be removed from the induction manifold. The air cleaner assembly is first taken off, followed by the fuel pipes and controls. The spring couplings between the two carburetters are withdrawn by slackening their pinch bolts, and each carburetter removed separately.

If the carburetter top cover and gasket is taken off by withdrawing the fixing screws, most of the internal components are exposed to view, as on **FIG 2:12**. When reassembling, any damaged gaskets or washers, and

such small items as split-pins, should be replaced with new ones.

Carburetter components which may require attention are in the main removable without taking the carburetter apart. The main jet assembly, pilot jet and starter fuel jet can all be detached from the exterior. If stoppages occur in any of these, the jets must never be probed with stiff wire, but blown through by air under pressure until clear.

2:9 Type B321 H carburetter

This type of Solex carburetter is fitted to 1598 cc engines from No. HB6799 to No. HB27985. From the details given on **FIG 2:13** it will be seen that it is similar to the type just described, except for the absence of the accelerator pump, and the different form of jet block. Synchronizing procedure is precisely as already detailed, the same particulars being used to obtain correct adjustment of the float level, and for synchronization and slow-running adjustment. The jet block is shown in detail on **FIG 2:14**.

On the final production 1598 cc engines, the Solex carburetters were replaced by Stromberg type, as described later in this chapter.

2:10 SU constant-vacuum type carburetter

Twin carburetters of SU manufacture are fitted to the 'Spitfire'. The principle differs from that of the Solex type already described, as the throughway area is varied by an air-control piston under the influence of induction manifold depression on the principle shown on **FIG 2:15**. A specially-tapered needle moving in the jet, and attached to the air-control piston, meters the fuel delivery from the jet in correct proportion to the air-flow in the throughway. The arrangement of these components is shown on **FIG 2:16**, while an exploded view is on **FIG 2:17**.

On each carburetter there are only three adjustments, comprising the usual throttle-stop screw, a fast-idle adjustment and provision for altering the height of the jet in relation to the needle. Providing the components are correctly sized for the engine, it is only necessary for the slow-running mixture to be correct, to ensure that the mixture will be correct throughout the range of operation. This is a feature of the needle grading, and thus changes of needle must not be made in an effort to remedy supposed carburetter troubles.

2:11 Adjustment

Correct slow-running is obtained by adjustment of the throttle-stop screw in conjunction with the jet adjusting nut. Before carrying out such operations, the engine must, as emphasized earlier, be in fully serviceable condition in all respects. The air cleaner system should first be removed so as to leave the air intakes accessible. Next check the coupling on the interconnecting throttle shaft, to ensure that the actuating pins of the interconnecting clamping levers are set 0.015 in from the lower edge of the fork, and also that there is $\frac{1}{32}$ in endplay between the interconnecting clamping levers and the throttle nuts. This is made clear from **FIG 2:18**, the nut and clamping lever being shown at 3 and 4 respectively. Turn back the slow-running adjustment screw on each carburetter to allow the throttle to close completely, and with the interconnecting shaft adjusted as described, tighten the clamp

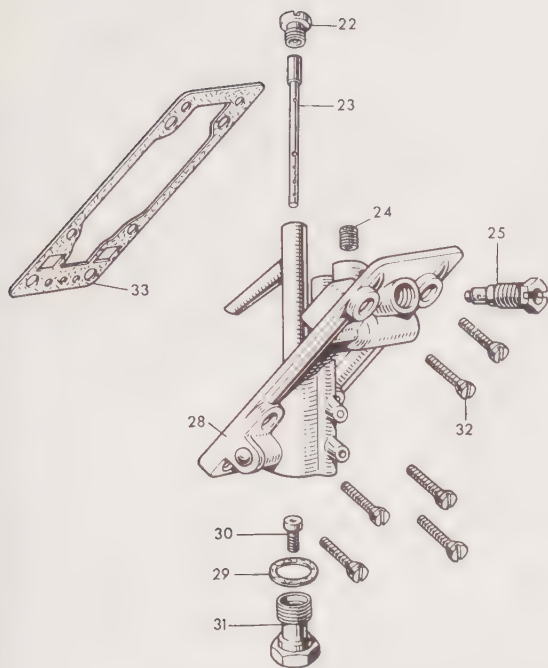


Fig 2:14 Jet block and components, Solex type B321H carburettor. (For part numbers refer to Fig 2:13.)

bolts. Check that the throttle action is synchronized, allowing of course for the slight clearance in the coupling pins and forks. Then screw the slow-running adjustment screws inwards for about a turn and a half, and see that both throttles open slightly to the same degree, and are so held by their individual screws. **FIG 2:18** will clarify the position of components.

The jet adjusting nuts are now screwed upwards, until the top of each jet is just level with the base of the throughway where this forms a bridge (**FIG 2:19**). Make sure that the same position is obtained on each jet, and then turn each adjusting nut two complete turns downwards. Start the engine, and when at normal operating temperature, adjust the two throttle adjustment screws in unison until an idling speed of about 700 rev/min is obtained. Listen carefully to the hiss of air at each intake, and if there appears to be a variation, carefully adjust the screws individually, but only by a small amount; this is all that should be necessary.

Next insert a wire spoke through each air intake in turn, with the engine idling at about 700 rev/min, push it under the air-piston (without in any way obstructing the air intake) and lift the piston about $\frac{1}{16}$ in (1.5 mm). If the mixture is weak, the two cylinders served by the particular carburettor will tend to cut out; if too rich the engine will speed up considerably, and will continue to do so when the air piston is lifted still further. To correct either fault, the jet adjusting nut must be screwed, upwards to weaken and downwards to enrich the mixture. In turning it upwards make sure that the jet head is also pushed upwards against the bottom face of the nut, as it may lag behind.

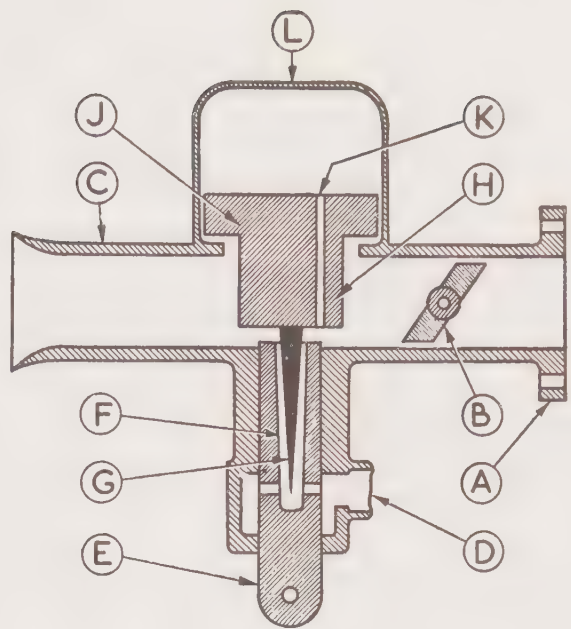


Fig 2:15 Principle of operation of SU carburettor.

Key to Fig 2:15 A Mounting flange. B Throttle valve. C Air intake. D Fuel intake. E Jet head. F Jet. G Needle. H Air slide. J Dashpot piston. K Air passage to dashpot. L Dashpot.

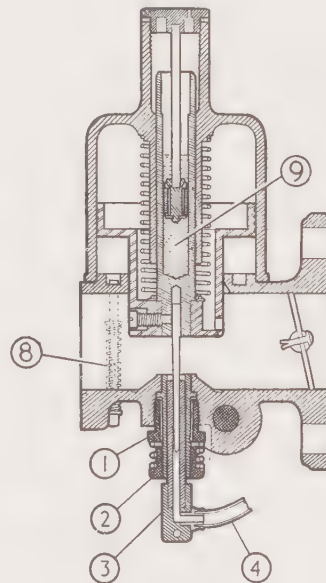
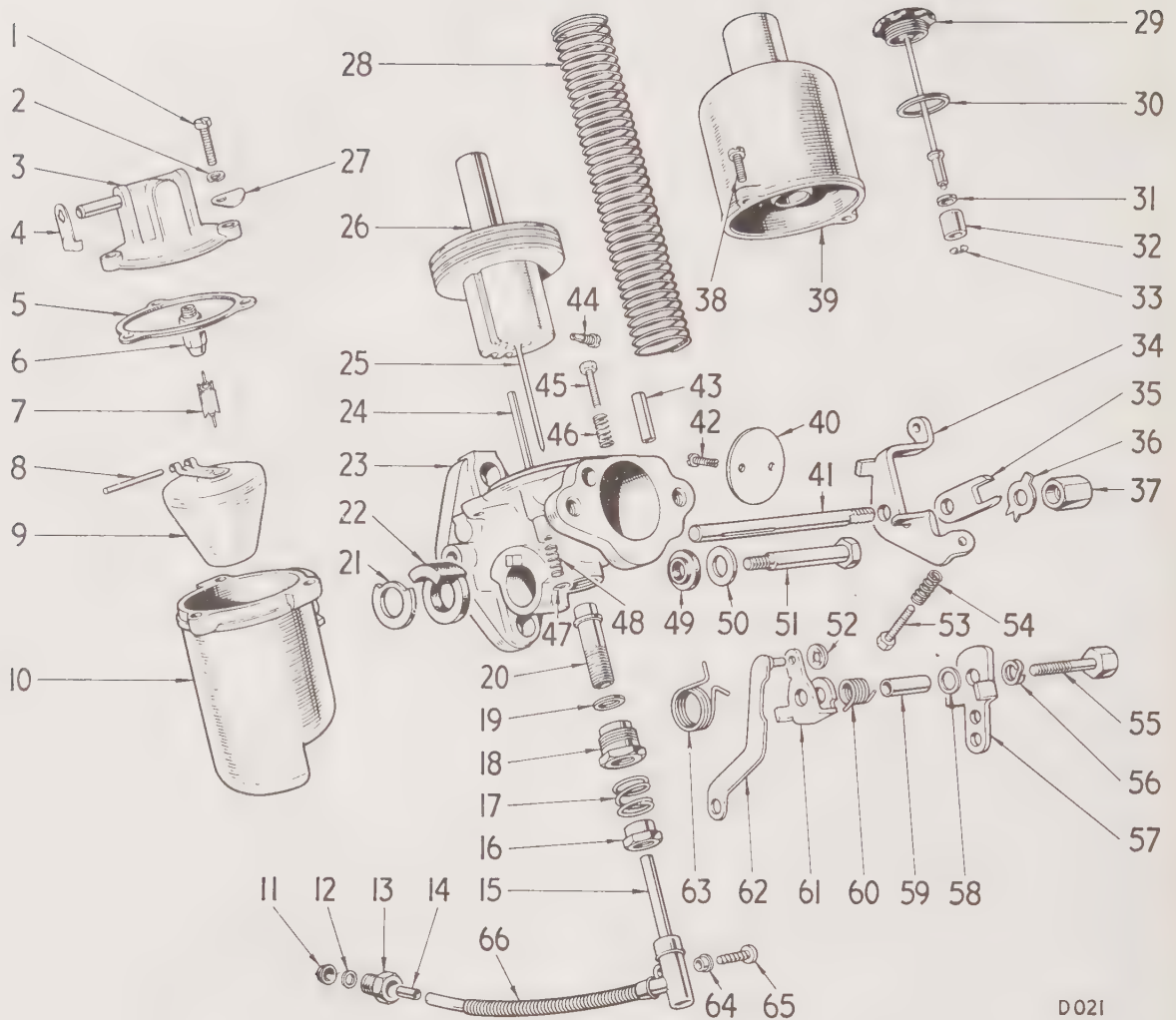


Fig 2:16 Section of SU carburettor.

Key to Fig 2:16 1 Jet gland nut. 2 Jet adjusting nut. 3 Jet assembly. 4 Fuel tube from float chamber. 8 Piston lifting pin. 9 Oil well in damper.



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Fig 2:17 Components of SU carburetter.

Key to Fig 2:17 1 Screw. 2 Spring washer. 3 Float chamber lid. 4 Breather hole shroud. 5 Gasket. 6 Needle valve body. 7 Needle valve. 8 Float spindle. 9 Float. 10 Float chamber. 11 Cup. 12 Washer. 13 Union nut. 14 Sleeve. 15 Jet. 16 Adjusting nut. 17 Spring. 18 Gland nut. 19 Washer. 20 Jet holder. 21 Washer. 22 Rubber seal. 23 Main body. 24 Lifting pin. 25 Needle. 26 Piston. 27 Identification plate. 28 Spring. 29 Cap. 30 Washer. 31 Washer. 32 Piston. 33 Circlip. 34 Throttle adjusting bracket. 35 Throttle fork. 36 Lock tab. 37 Nut. 38 Screw. 39 Vacuum chamber. 40 Throttle disc. 41 Throttle spindle. 42 Screw. 43 Mixture enrichment cable abutment. 44 Needle retaining screw. 45 Throttle adjusting screw. 46 Spring. 47 Circlip. 48 Spring. 49 Rubber seal. 50 Plain washer. 51 Bolt. 52 Circlip. 53 Throttle adjusting screw. 54 Spring. 55 Bolt. 56 Spring washer. 57 Cam lever. 58 Distance washer. 59 Tube. 60 Return spring. 61 Pick-up lever. 62 Jet lever. 63 Return spring. 64 Shouldered washer. 65 Screw. 66 Flexible pipe.

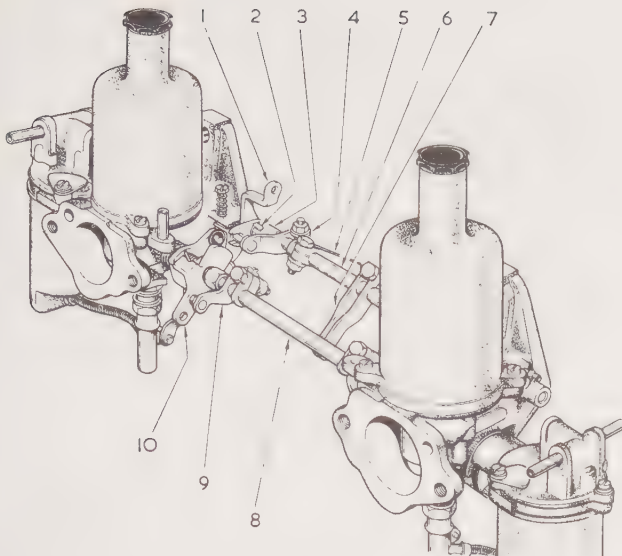


Fig 2:18 Twin SU carburetters with coupling details shown.

Key to Fig 2:18 1 Throttle return lever—rear. 2 Tab washer. 3 Throttle spindle nut. 4 Throttle clamping lever. 5 Throttle connecting rod. 6 Throttle actuating lever. 7 Choke control connecting rod. 8 Choke clamping lever. 9 Choke actuating lever.

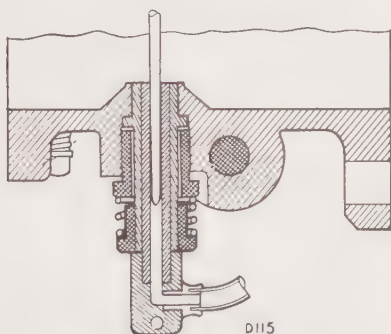


Fig 2:19 Position of SU jet when level with bridge, as explained in text.

The throttle idling adjustment may require attention to keep the engine at a sensible idling speed while adjusting the jets. When turning the jet nuts, move each only one flat at a time (one-sixth of a turn), and do not allow a wide difference in position to occur; this is evidence of a fault elsewhere. When all is correct, very slight lifting of each air piston by the wire spoke should cause an increase in idling speed, indicating that the mixture is very slightly rich; further movement will then cause the engine to stall.

As a final check, listen to the exhaust note. A splashy beat indicates weak mixture, and a heavy thumpy note over-richness, often accompanied by black smoke. It is undesirable to attempt an excessively low idling speed, and 750 rev/min is not considered to be too fast. It is usually unnecessary to readjust in any way after replacing the air-cleaner, as the resistance to air-flow is negligible with a properly-maintained filter.

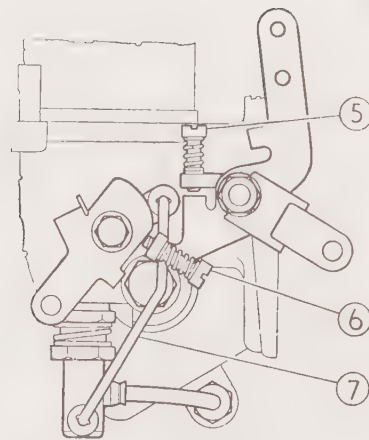


Fig 2:20 Jet and throttle interconnection on SU carburetter.

Key to Fig 2:20 5 Throttle adjusting screw. 6 Linkage adjusting screw. 7 Link to jet.

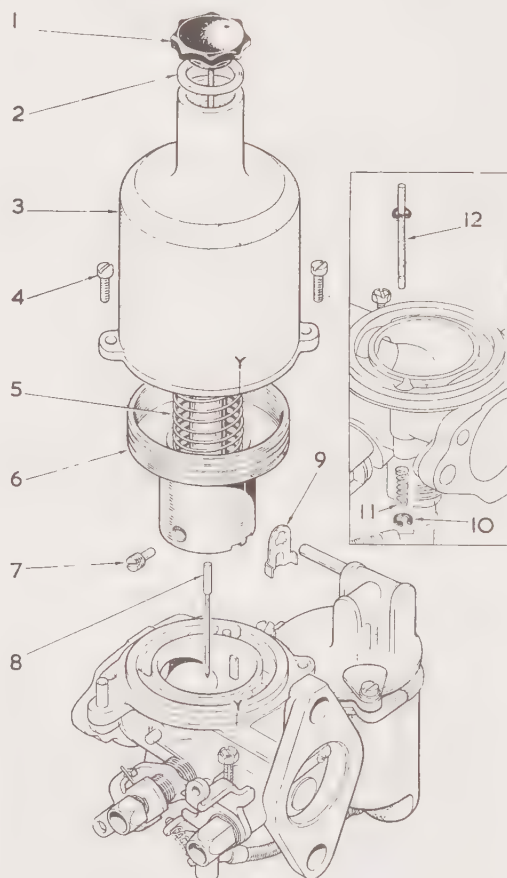


Fig 2:21 SU dashpot, piston and associated components

Key to Fig 2:21 1 Damper. 2 Damper washer. 3 Suction chamber. 4 Chamber retaining screws. 5 Piston ring. 6 Piston assembly. 7 Needle locking screw. 8 Needle. 9 Baffle plate. 10 Circlip. 11 Spring for lifting pin. 12 Piston lifting pin. YY Marks for refitting.

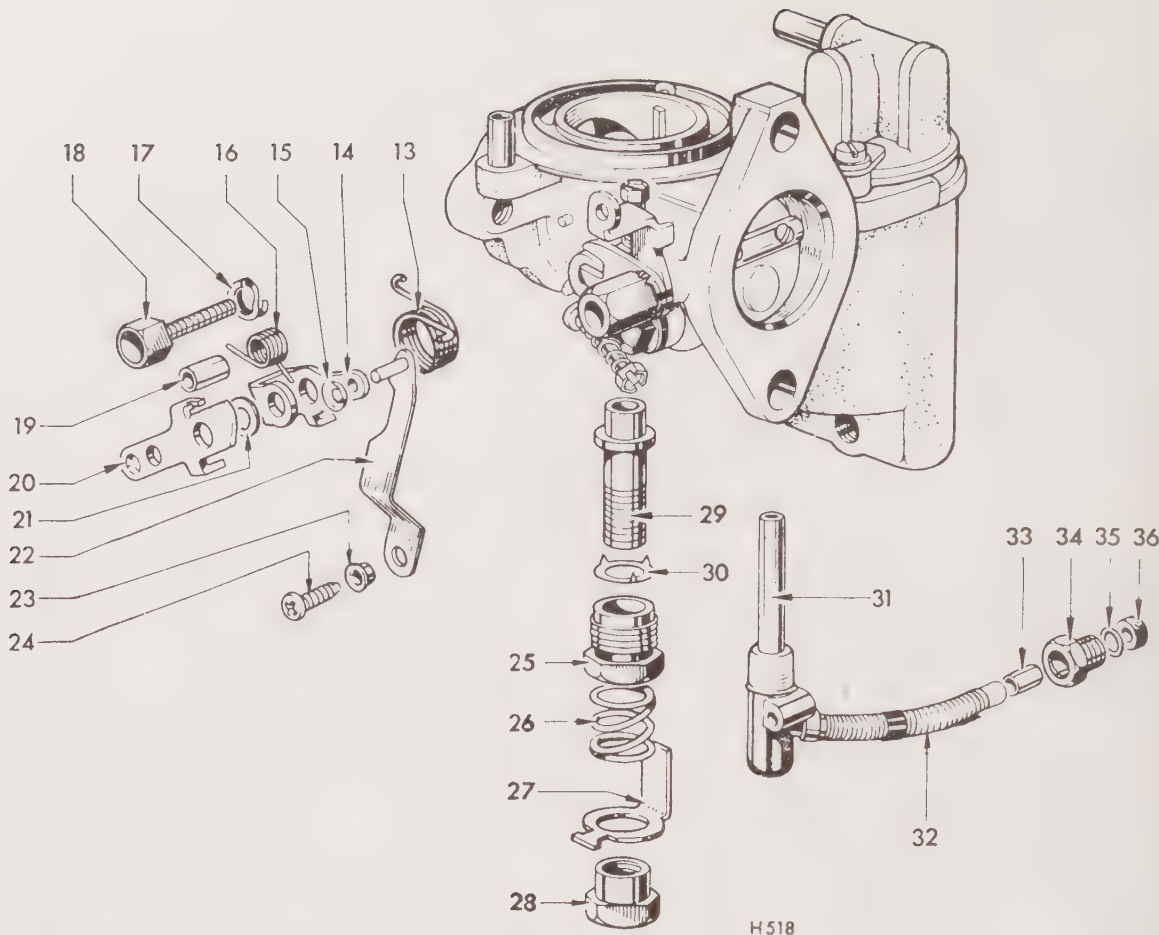


Fig 2:22 SU carburettor jet and linkage.

Key to Fig 2:22 13 Lever return spring. 14 Pick-up lever. 15 Link retainer. 16 Pick-up lever spring. 17 Double spring washer. 18 Lever pivot bolt. 19 Pivot bolt tube. 20 Cam lever. 21 Washer. 22 Lever/jet link. 23 Ferrule. 24 Link retainer screw. 25 Jet locking nut. 26 Spring. 27 Jet nut restrictor (U.S.A. only). 28 Jet adjusting nut. 29 Jet bearing. 30 Lock washer. 31 Jet assembly. 32 Flexible jet tube. 33 Ferrule. 34 Sleeve nut. 35 Washer. 36 Gland.

2:12 Overhauling

For starting from cold, the jet is pulled down by a hand control, this in effect enlarging its bore in relation to the needle and providing a rich mixture. At the same time the throttle is opened slightly by a link. This fast-idling setting is adjustable by the screw shown on **FIG 2:20**.

The air-piston and its associated parts constitute a moving element on which the carburettor depends for its correct working. At all times the piston must be quite free, and when lifted by the testing pin (**FIG 2:21**) it should fall easily against the small amount of damping caused by the hydraulic damper piston, and should come to rest on the raised part of the casting, or bridge at the top of the jet, with a distinct click. If the needle is bent, it is liable to

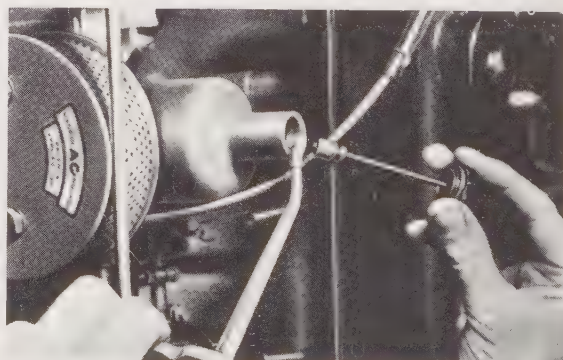


FIG 2:23 Hydraulic damper piston withdrawn from SU carburettor for addition of lubricant, or other purposes.

foul the jet, but assuming the needle is undamaged it is still possible for fouling to occur if the jet is off centre. To centre the jet, first disconnect the operating rod from its base, and undo the junction of the nylon feed tube at the float chamber. Then withdraw the jet along with the tube. Referring to **FIG 2:22**, slacken the jet locking screw or gland nut, when it will be possible to rotate the jet bearing with the fingers. Take off the adjusting nut and spring and replace the jet temporarily.

Next take the top cap from the dashpot chamber, and withdraw the hydraulic damper piston, as shown on **FIG 2:23**. With a pencil press down on top of the piston rod centre, to hold the piston firmly against the top of the jet bridge. This means that the needle is in its absolute lowest position. The jet locking screw is then tightened, noting at the same time that the head of the screw is in the correct position for its hole to be aligned with the operating rod. The action must now be tested both with the jet fully up, and with it in intermediate and fully down positions. If necessary repeat the centring operation, until clearance is obtained at all times. When all is correct, the jet is withdrawn and then refitted along with its nut and spring. At long intervals the dashpot chamber and air piston shown on **FIG 2:21** will require a thorough cleaning in petrol. The chamber is secured by two screws and can be lifted off after removing both these and the hydraulic damper. When removing the air-piston and needle, take great care not to bend the latter. If it is removed from the piston, the needle must be replaced with its shoulder flush with the piston underside (**FIG 2:24**).

When reassembling the dashpot and piston, apply a little thin oil to the piston-rod and its bore. Do not attempt to modify the return spring, as this is specially selected for the engine. When replacing the damper piston, use damping oil of the specified grade. The purpose of this damper is to cause a momentary lag on piston movement under sudden throttle opening, thus providing a temporarily rich mixture, in the same function as the accelerator pump on a fixed-choke carburetter.

The float chamber assembly is shown on **FIG 2:25** it being noted that the float is of the hinged type with a pivot on the lid. To check the level, invert the lid and insert a gauge of $\frac{3}{16}$ in thickness between the lid and float (**FIG 2:26**). A suitable slip gauge can be made from mild steel strip ground to size. If necessary the float lever must be carefully bent to obtain this setting. Needle valves give little trouble for long periods, but when wear and leakage occurs the needle and seating are renewable as a unit.

2:13 Stromberg carburetter

This type of constant-vacuum horizontal carburetter is shown in detail on **FIG 2:27**. It is employed in a twin installation on engines of 1598 cc from No. HB27986, and all 1998 cc engines as shown on **FIGS 2:28** and **2:29**. The carburetter is designated 150 CD (constant depression), and operation is similar to that of the SU carburetter but the construction is different, notably in the use of a flexible diaphragm instead of a floating piston for controlling the air-slide and jet needle.

From the section shown in **FIG 2:30** it will be noted that the float chamber is concentric with the main body

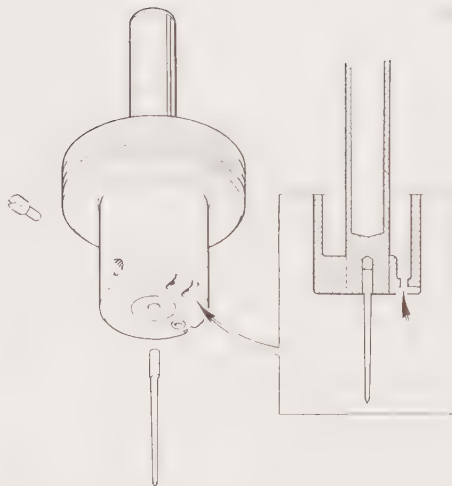


Fig 2:24 Correct position of SU needle in air piston.

surrounding the central jet. There are three main aluminium castings comprising the main body, float chamber and suction chamber cover. Alloy castings are also used for the air-valve body and jet housing. For starting there is a device interconnected with the throttle, providing a fast-idle position for warming-up. The operating principle will be made clear if diagrams **FIG 2:27** and **2:30** are studied along with this description.

The plastic fuel pipe is connected to the petrol inlet, and from here fuel passes to the float chamber by way of the needle valve seating 33 and needle 72, the latter being controlled by twin rubber floats mounted on the pivot pin 44. From the float chamber the petrol passes to the jet orifice 45 via holes in the jet assembly, the level being maintained at the same height as in the float chamber, in the usual manner.

2:14 Starting and idling

When the choke control is operated, it actuates the lever at the side of the carburetter, this rotating the starter bar 54 to lift the piston-type air-valve 5. This valve has a metering needle 8 at its base, which passes down the jet orifice to control the effective bore of the jet. Thus when raised in the foregoing manner, the mixture is enriched for cold starting. Simultaneously with this, a cam on the lever opens the throttle beyond the normal idling position, as adjusted by means of the fast idle stop screw 23 this providing the faster idling speed required when warming up. As soon as the engine starts, the induction manifold vacuum will lift the air-valve 5, thus weakening the mixture satisfactorily to prevent over-richness. The car can be driven away on this setting of the choke control, but the latter must be progressively released as the engine warms up, until the control is right out of action. The engine will idle in neutral at a speed determined by the

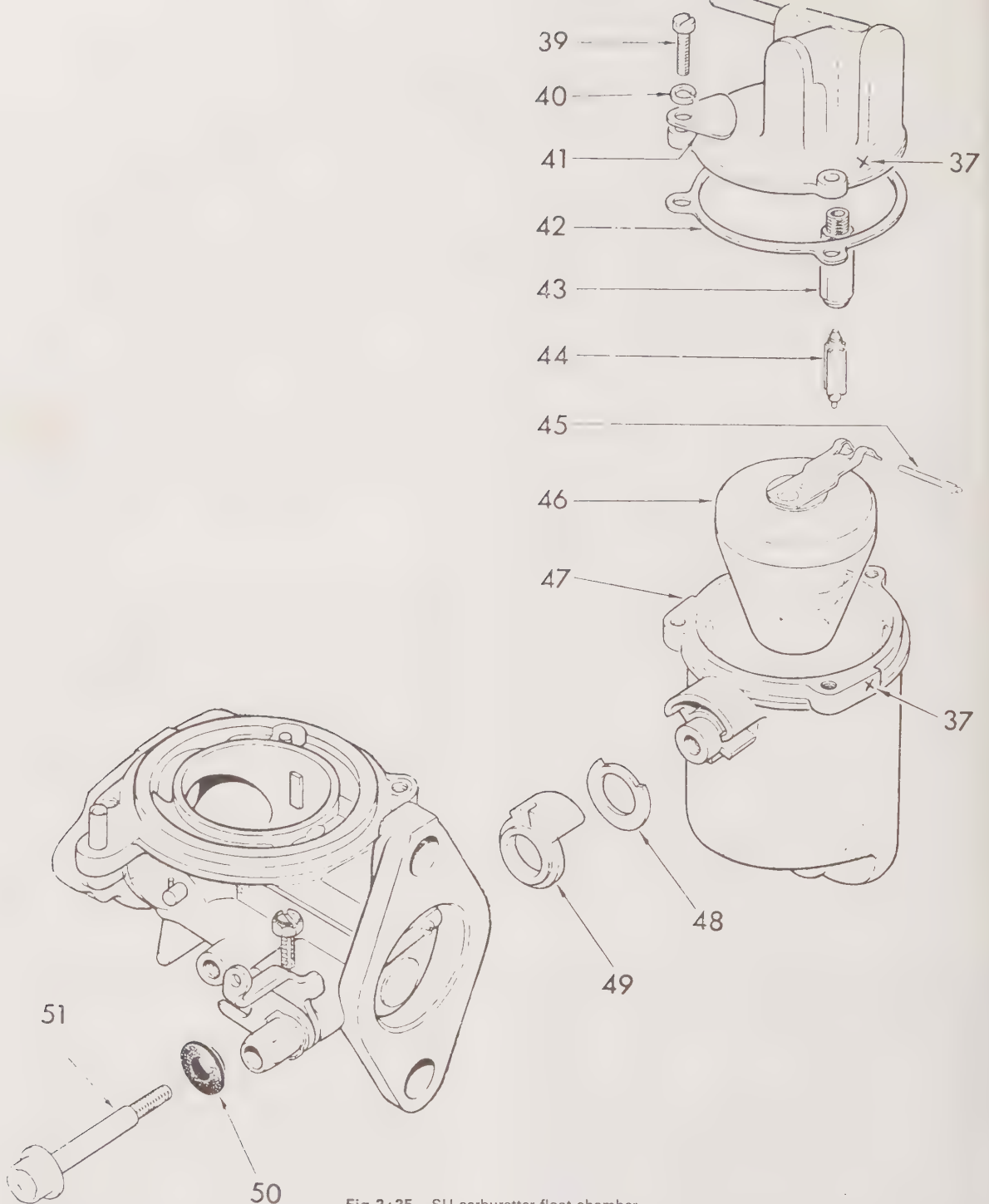


Fig 2:25 SU carburettor float chamber.

Key to Fig 2:25

37 Marks for refitting.	38 Float chamber lid.	39 Lid retaining screws.	40 Spring washers.
41 Identification plate.	42 Lid gasket.	43 Needle seating.	44 Float needle.
45 Float hinge pin.	46 Float assembly.	47 Float chamber.	48 Backing washer (steel).
49 Rubber mounting.	50 Rubber washer.	51 Retaining bolt.	

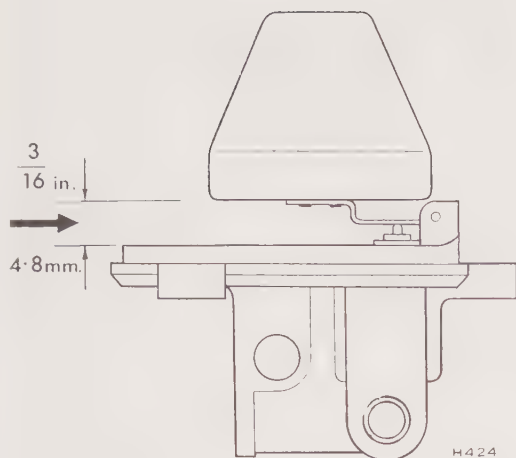


Fig 2:26 Checking float level, SU carburetter

throttle-stop screw 58. It will be seen that there is no separate idling circuit, the mixture being provided from the main jet and main air intake. The fuel quantity is determined by the actual height of the main jet in the carburetter body, and this can be adjusted by the adjusting screw 39 at its base. Turning the screw clockwise decreases the mixture strength, while anti-clockwise will enrich it. The throttle-stop screw 58 is adjusted to obtain a satisfactory idling speed. It is important to note that the throttle pedal must not be depressed when starting from cold, but this may be done as soon as the engine fires.

2:15 Normal running

Under running conditions, the manifold vacuum is transferred by way of a passage in the air-valve, to the suction chamber 69. This chamber has a diaphragm 4 at its base, which seals it from the main body. It will be evident that the pressure difference between the chamber 69 and the air-intake at atmospheric pressure, will cause the diaphragm, and with it the air-valve, to be pulled upwards towards the suction chamber. This action will not only increase the bore of the carburetter throughway, but will also draw the metering needle out of the jet, so allowing more fuel to pass. The lift of the air valve is in proportion to the weight of air passing through the throttle valve, and as the jet needle is graded along its length to very close limits, the mixture ratio is maintained in line with the requirements of the engine, at any combination of rev/min and load.

In the suction chamber, it will be noted that a hydraulic damper piston is fitted inside the top guide. By preventing a sudden upward movement of the air valve when the throttle is quickly opened, a richer mixture than normal is provided temporarily for assisting rapid acceleration. (This device takes the place of the accelerator pump on a fixed-choke carburetter.) The damper piston is suspended from the top screw of the suction chamber. It operates in oil contained in the hollow guide-rod, this being filled to within 0.25 in of the rod end with oil of SAE 20 viscosity.

The air-valve is lifted against a helical compression spring, which has to be specially graded. Apart from the

float-needle valve, this spring and the jet needle are the only two components requiring selection.

2:16 Adjustments

For adjusting the idling, particularly after overhaul when the original setting may have been lost, the air-valve 5 is held down on to the bridge in the throttle bore (the air cleaner being removed). The jet adjustment screw 39 is then screwed upwards with a coin, until the top of the jet can be felt to contact the underside of the air valve. From this position, turn the jet screw the other way, i.e. downwards, for three turns. This provides a good approximate position from which to start. Referring to FIG 2:31, the engine is now run until it is at normal temperature, and the idling adjusted by screw 3 to a satisfactory figure; do not attempt to obtain an excessively slow speed. At the same time, the jet screw should be turned slightly to obtain smooth and regular firing, but only a little movement should be called for. When screwed upwards the engine may speed up initially, but further movement will cause it to stall. From this point, the screw must then be turned downwards, until firing is even at the desired slow-running speed. The air valve 5 (FIG 2:27) should now be lifted (via the air-intake) by means of a wire spoke or similar instrument, for a very short distance, say $\frac{1}{32}$ in or a little more. If the speed rises, the mixture may be rather too rich, but if the engine stalls it is too weak; as a rule it is best to err very slightly on the rich side. When the idling speed is correct, it follows that the mixture range throughout the throttle movement will also be in order, i.e. with the correct needle and air-valve spring fitted.

2:17 Synchronization

It is essential that the two carburetter throttles operate in unison, and this can be ensured by first slackening the clamp bolts on the interconnecting coupling, and then unscrewing the throttle-stop screws 3 (FIG 2:31) so that both throttle butterflies can close completely. The coupling bolts are then retightened. Now adjust each throttle-stop screw 3 so that its tip is just touching on the stop lever on the throttle spindle.

From this point, turn each screw one complete turn, ensuring that each one is taking the load of its individual throttle, i.e. that there is no load imposed on the interconnecting spindle in consequence of the two screws being adjusted differently. Each carburetter should then have its jet screw adjusted as already detailed. With the engine at running temperature the procedure for setting the idling is as previously described. Each carburetter is treated individually, except that the throttle-stop screws must be adjusted in unison for the reason stated above. When applying the piston-lift test with the spoke, the effect will be noted on the cylinders served by that particular carburetter, and the aim must be to obtain an identical effect on each group of cylinders. Finally, adjust screw 4 (FIG 2:31) to give a gap of $\frac{1}{16}$ in (1.575 mm) at the point shown.

It must be appreciated that satisfactory performance will not be obtained if other systems of the engine such as ignition and valve-gear, are faulty or out of adjustment. Also, after a long mileage wear will take place in the carburetter throttle spindle bearings, to affect performance adversely. In this case, service replacements should be fitted.

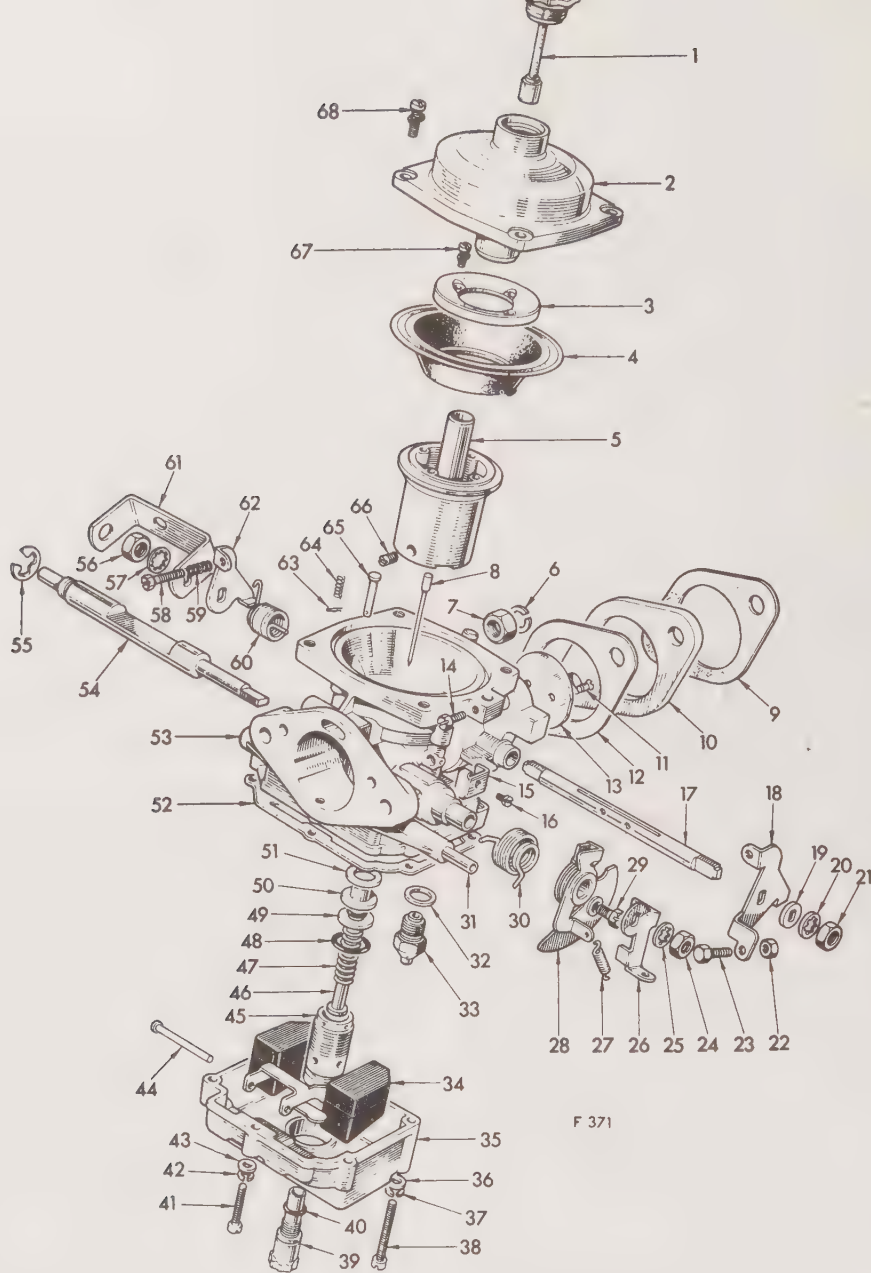


Fig 2:27 Components of Stromberg carburettor.

Key to Fig 2:27

- | | | | | |
|-----------------------|---------------------------|-------------------------|-------------------------|------------------------|
| 1 Damper. | 2 Top cover. | 3 Retaining ring. | 4 Diaphragm. | 5 Air valve assembly. |
| 6 Spring washer. | 7 Nut. | 8 Metering needle. | 9 Gasket. | 10 Insulating washer. |
| 11 Screw. | 12 Gasket. | 13 Throttle. | 14 Choke cable screw. | 15 Cover plate. |
| 16 Screw. | 17 Throttle spindle. | 18 Fast idle lever. | 19 Plain washer. | 20 Spring washer. |
| 21 Nut. | 22 Nut. | 23 Fast idle screw. | 24 Nut. | 25 Spring washer. |
| 26 Choke lever. | 27 Spring. | 28 Choke cam assembly. | 29 Screw. | 30 Spring. |
| 31 Petrol inlet pipe. | 32 Washer. | 33 Needle seating. | 34 Float assembly. | 35 Float chamber. |
| 36 Plain washer. | 37 Spring washer. | 38 Screw. | 39 Jet adjusting screw. | 40 'O' ring. |
| 41 Screw. | 42 Spring washer. | 43 Plain washer. | 44 Float spindle. | 45 Jet assembly. |
| 46 Jet. | 47 Spring. | 48 'O' ring. | 49 Washer. | 50 Orifice bush. |
| 51 Washer. | 52 Gasket. | 53 Body. | 54 Starter bar. | 55 Retaining clip. |
| 56 Nut. | 57 Spring washer. | 58 Throttle stop screw. | 59 Spring. | 60 Spring. |
| 61 Throttle lever. | 62 Throttle stop bracket. | 63 Retaining clip. | 64 Spring. | 65 Piston lifting pin. |
| 66 Screw. | 67 Screw. | 68 Screw. | | |

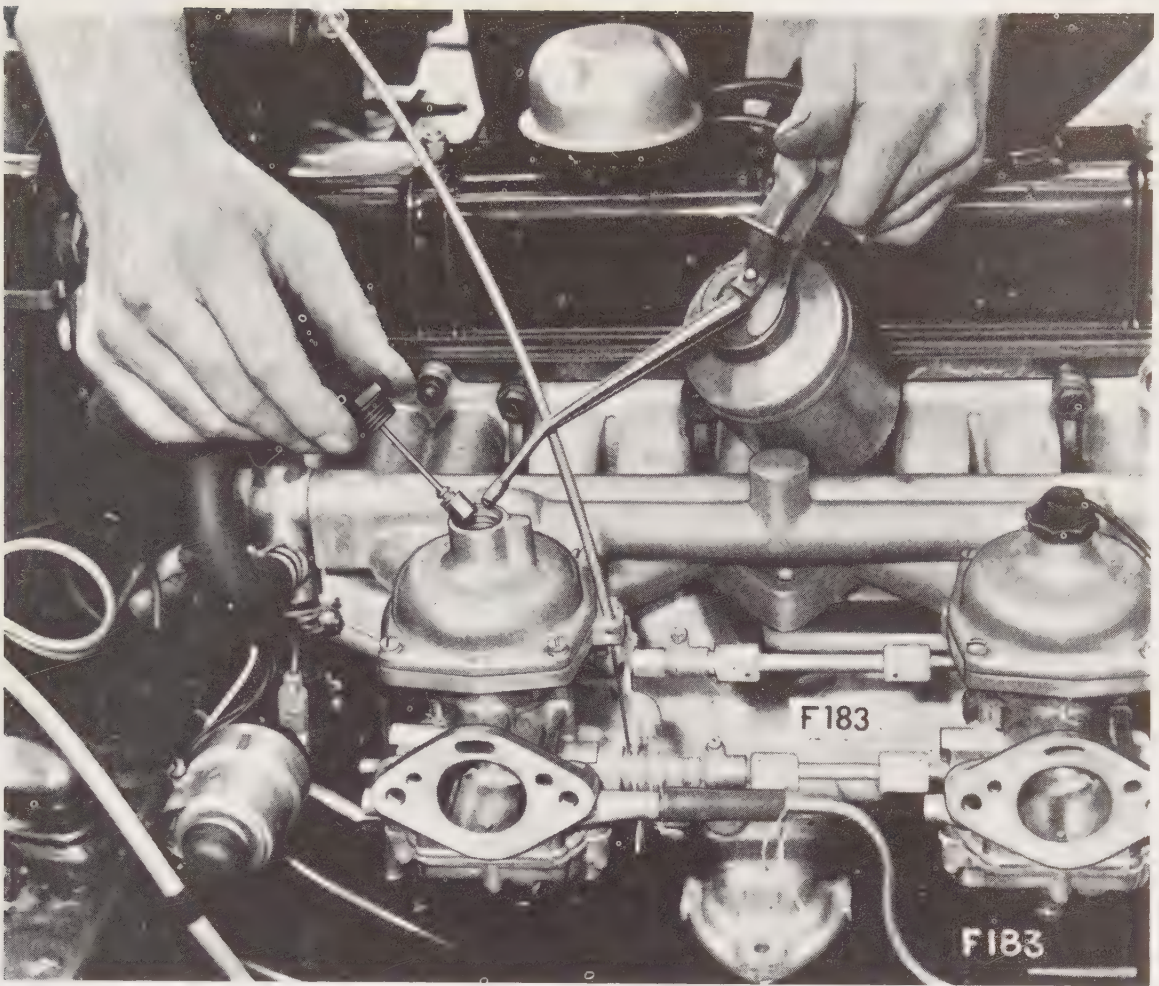


Fig 2:28 Twin Stromberg carburetters installed on 2-litre engine.

2:18 Float level

The float level is correct, when, with the carburettor inverted, the highest point of the float is approximately $\frac{3}{4}$ in (18 mm) above the face of the main body, with the fuel needle valve on its seating (see FIG 2:32). If the level needs to be reset, this is done by bending the tag that contacts the end of the needle 72 (FIG 2:30). This tag must be at right angles to the needle when the latter is in the closed position. The level can be lowered by fitting an extra washer under the needle valve assembly, and this is a simple way of obtaining a small change in level without any bending of parts. The float chamber is shown removed on FIG 2:33.

2:19 Constructional points

It will be apparent that movement of the air-valve and jet needle must be completely unobstructed. Such obstruction can be caused by the needle binding in the jet, but the construction allows for centralization of these parts, as there is an annular clearance around the orifice

bush 45 (FIG 2:27). This allows the bush and jet to be positioned laterally, and then clamped in the most suitable position to ensure free needle movement in its bore. To check that the movement is free, the air-valve can be lifted by the pin 65, and its descent checked. If the movement is defective, and centring is required, the air valve 5 must first be lifted, and the jet assembly fully tightened. The jet is screwed up until its tip is just above the bridge. The jet assembly is now slackened off about half a turn, this releasing the orifice bush 45. Now allow the air-valve 5 to drop so that the needle re-enters the jet. This action will automatically centralize the jet. If the air-valve is reluctant to drop, it can be assisted by removing the top cap and damper from the suction chamber, and pushing the air-valve down with a copper rod from above.

The jet assembly is now slowly tightened, with frequent checks to make sure that the needle is quite free. This is done by lifting the air-valve about 0.25 in and letting it drop. It should at all times abut firmly on the bridge, with no prior checks to movement. If at any time the air-valve

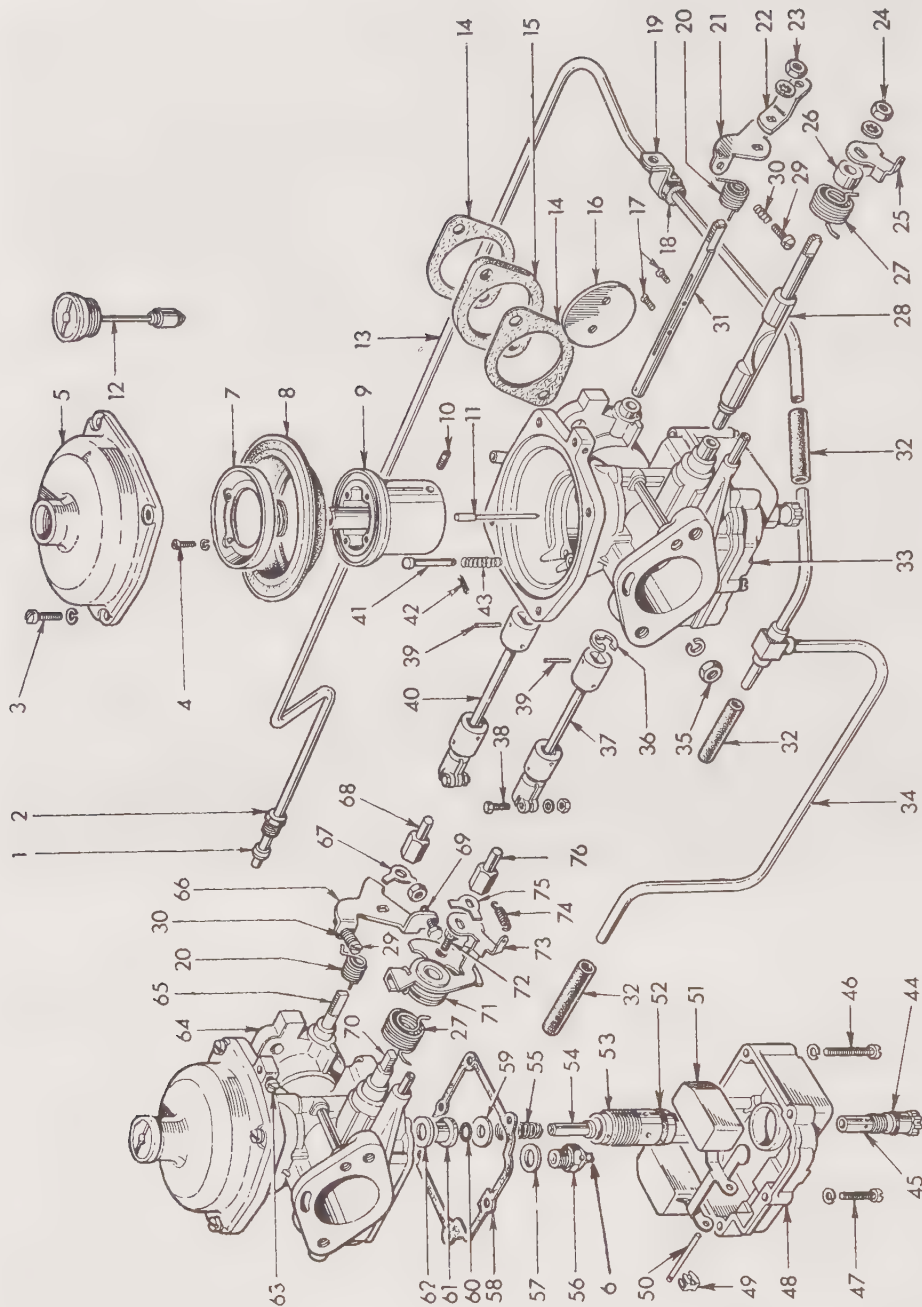


Fig 2:29 Components of twin Stromberg carburettor installation.

Key to Fig 2:29 1 Sleeve, 2 Nut, 3 Screw, 4 Screw, 5 Cover, 6 Needle, 7 Retaining ring, 8 Diaphragm, 9 Air valve, 10 Locking screw, 11 Needle, 12 Damper, 13 Pipe, 14 Gasket, 15 Insulator, 16 Throttle, 17 Screw, 18 Grommet, 19 Bracket, 20 Spring, 21 Stop, 22 Lever, 23 Nut, 24 Nut, 25 Lever, 26 Bush, 27 Spring, 28 Starter bar, 29 Screw, 30 Spring, 31 Spindle, 32 Connection, 33 Float chamber, 34 Pipe, 35 Nut, 36 Retaining ring, 37 Coupling, 38 Bolt, 39 Pin, 40 Coupling, 41 Pin, 42 Clip, 43 Spring, 44 'O' ring, 45 Adjusting screw, 46 Screw (long), 47 Screw (short), 48 Float chamber, 49 Clip, 50 Pin, 51 Float assembly, 52 'O' ring, 53 Bushing screw, 54 Jet, 55 Spring, 56 Needle seat, 57 Washer, 58 Gasket, 59 Washer, 60 'O' ring, 61 Bushing, 62 Washer, 63 Screw, 64 Body, 65 Spindle, 66 Stop, 67 Washer, 68 Nut, 69 Screw, 70 Starter bar, 71 Lever, 72 Screw, 73 Lever, 74 Spring, 75 Washer, 76 Nut.

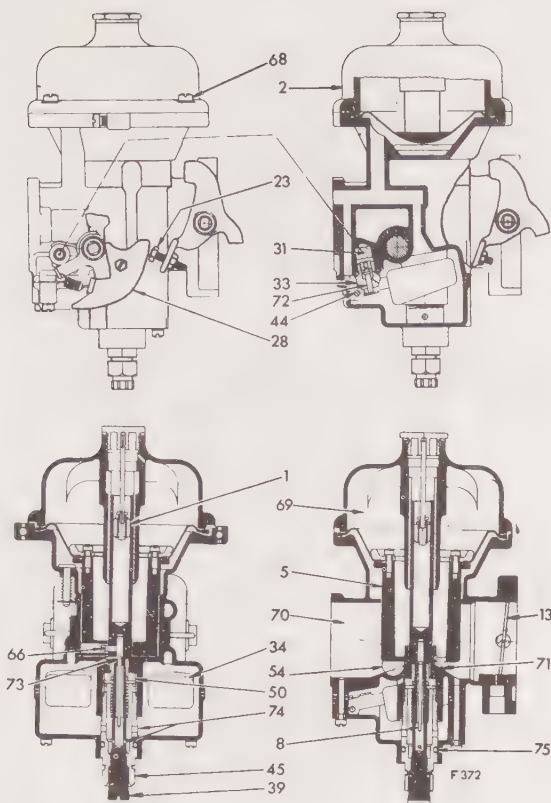


Fig 2:30 Sectional view of Stromberg carburettor. (For certain part numbers refer to **Fig 2:27**. Remainder below.)

Key to Fig 2:30 69 Dashpot chamber. 70 Air intake.
71 Jet bridge. 72 Float needle. 73 Jet orifice.
74 Fuel passages. 75 'O' ring.

itself shows signs of sticking, this is probably due to dirt on its exterior. The valve assembly is removed by undoing the screws and taking off the top cover, when the assembly complete with its diaphragm can be lifted off the main body, releasing the diaphragm (**FIG 2:34**). The air-valve and the carburettor bore should be cleaned with paraffin, also the diaphragm. Petrol may be used, but this causes expansion of the diaphragm which must then be allowed to dry thoroughly before refitting so that it will locate properly.

Obviously if the jet needle is bent, free movement is impossible. The needle must therefore be handled carefully at all times. When fitting, its lower shoulder must line up with the lower face of the air-valve; the locking screw must always be fully tightened. The diaphragm has a beading and locating tab moulded to both its inner and outer radii, this ensuring correct positioning. It is secured to the air-valve by a ring, held by screws with lock-washers. When assembling, the beading must be correctly located, and the screws fully tightened. For the outer edge of the diaphragm a location channel is provided at the top of the main carburettor body, and it is important that the beaded edge of the diaphragm is pro-

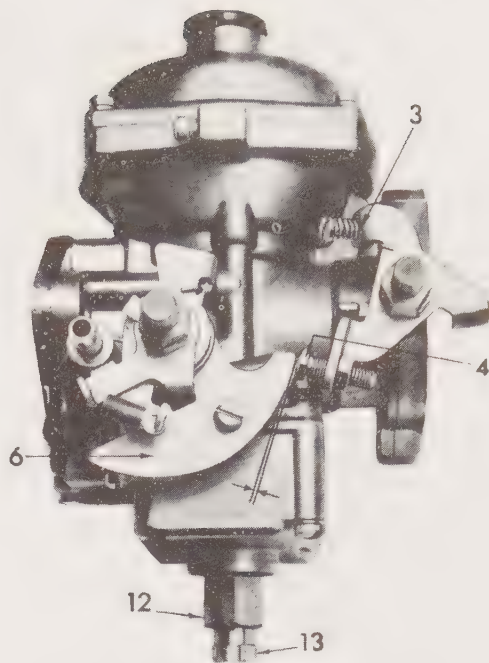


Fig 2:31 Adjustments of Stromberg carburettor.

Key to Fig 2:31 3 Slow-running screw. 4 Cam screw.
6 Cam. 12 Jet nut. 13 Jet adjusting screw.

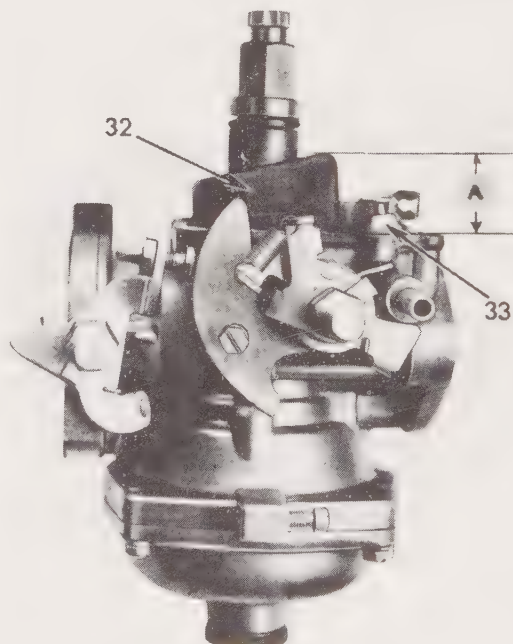


Fig 2:32 Float level adjustment on Stromberg carburettor. Dimension A = $\frac{3}{4}$ in (18 mm).

Key to Fig 2:32 32 Float. 33 Needle valve.

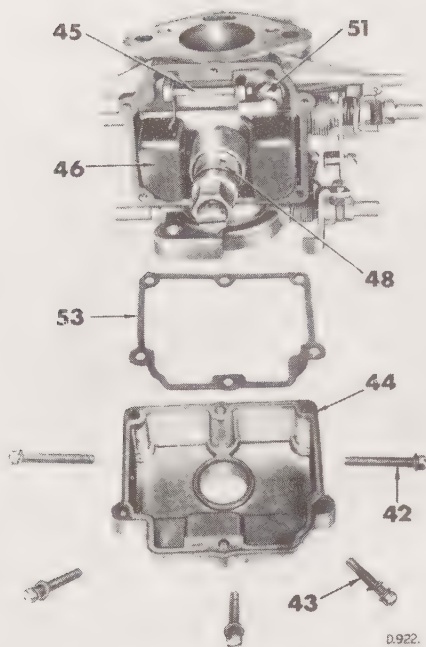


Fig 2:33 Stromberg carburettor with float chamber removed.

Key to Fig 2:33
 42/43 Screws. 44 Float chamber
 45 Float hinge pin. 46 Twin floats. 48 Jet assembly.
 51 Needle valve. 53 Gasket.

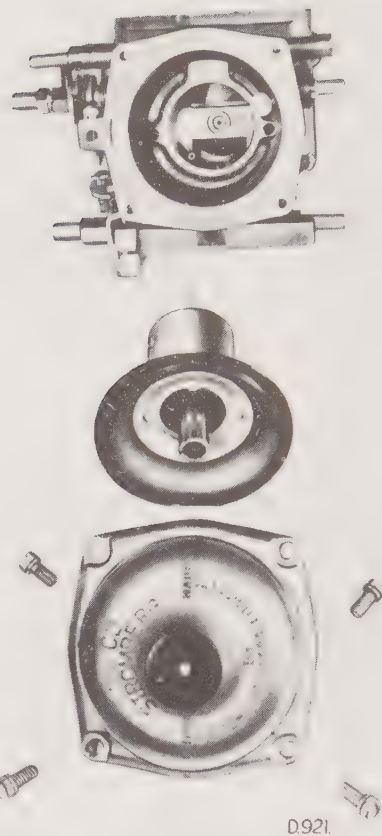


Fig 2:35 Stromberg carburettor with air-piston and diaphragm removed from main body.

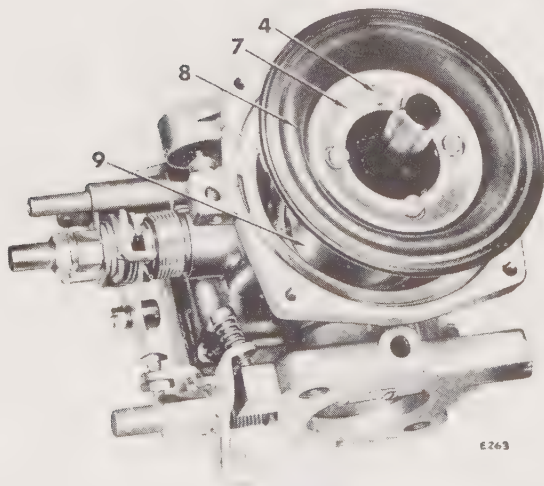


Fig 2:34 Stromberg carburettor with dashpot chamber removed.

Key to Fig 2:34
 4 Diaphragm screws. 7 Diaphragm plate.
 8 Diaphragm. 9 Air piston.

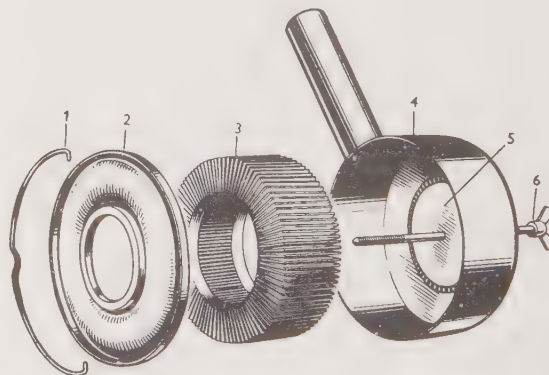


Fig 2:36 Typical paper element type air filter.

Key to Fig 2:36
 1 Clip. 2 Endplate. 3 Element. 4 Casing.
 5 Outer endplate. 6 Centre bolt.

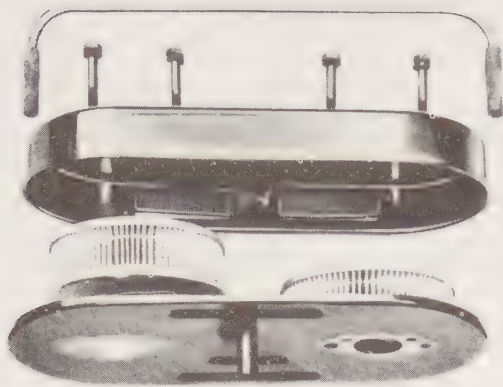


Fig 2:37 Two air cleaner elements combined in one casing

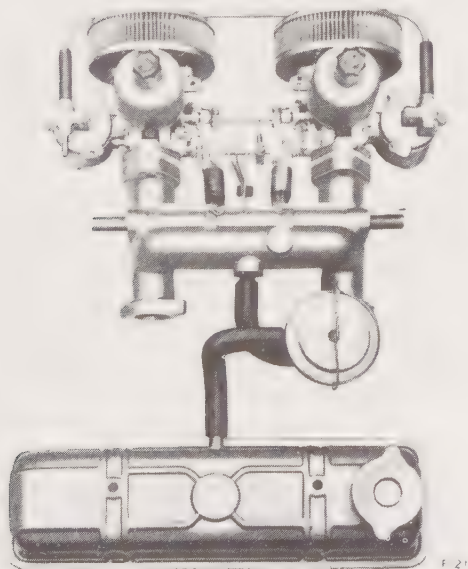


Fig 2:38 Closed-circuit breathing system incorporating plate-valve, as used on later engines.

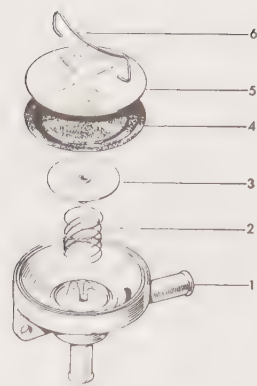


Fig 2:39 Components of breather valve.

Key to Fig 2:39 1 Duct from rocker box. 2 Spring.
3 Valve plate. 4 Washer. 5 Cover. 6 Clip.

perly engaged therein. When the suction chamber cover is fitted it must be positioned so that the screw holes line up with those in the main body, so that the diaphragm will not be displaced when the cover is assembled. These components are shown dismantled on FIG 2:35.

The air-valve rod and its guide should be kept clean, and whenever dismantled a few drops of light oil should be applied to the working surfaces.

There is a rubber 'O' ring fitted between the float-chamber spigot boss and jet assembly. This must always be fitted correctly, and if leakage occurs the ring must be replaced.

2:20 Synchronizing devices

Various instruments and other devices are marketed aimed at enabling twin carburettors to be synchronized in the minimum time and without complication. Such aids are no doubt invaluable and time-saving in certain circumstances, and are also useful for checking adjustments made in accordance with the foregoing information. In the judgement of the author however, their use cannot be regarded as a satisfactory substitute for the operational sequence detailed, which if carefully carried out is not difficult and has time and again proved to give the best results.

2:21 Air cleaner

Different designs of air cleaner are fitted, depending on the type and number of carburettors. Paper-element types are shown on FIGS 2:36 and 2:37. Dismantling is a simple operation of removing the cover, after taking the cleaner off the carburetter; this exposes the paper element. All foreign matter must then be brushed out, and blown from the folds of the element. The latter should be replaced when unserviceable, as determined by operating conditions. Always ensure that the joint washers are in good order, and renew them if there is any sign of damage.

'Spitfire' engines of earlier type have gauze filters on each carburetter. Maintenance consists of washing the filter gauze in petrol at about 3000 mile intervals, and then soaking in clean engine oil. After allowing time for surplus oil to drain off, the cleaner is wiped over and refitted.

When replacing, take care that the holes in the carburettor flanges are aligned properly with the corresponding holes in the filters and flange gaskets.

Some 'Spitfire' engines may also have separate filters, but these are of paper-element type, which are dealt with in line with earlier information on this type.

Later 'Spitfire' and all six-cylinder types are fitted with the filter shown on **FIG 2:37** which, it will be noted, comprises two elements inside a single casing provided with air intake pipes. Removal of the bolts which attach the body to the carburettor flanges enables the filter to be taken off and dismantled, exposing the two elements. The latter are dealt with in accordance with previous remarks.

2:22 Emission control valve

Engines having closed-circuit crankcase ventilation, whereby the crankcase fumes are consumed in the engine, have an emission control valve connected in a duct between the rocker box and the induction manifold, as shown on **FIG 2:38**. The purpose of this is to regulate the degree of vacuum applied to the rocker box in accordance with throttle opening.

The valve unit should be removed occasionally by releasing the hose connections and detaching the assembly from its bracket. The components are visible after taking off the clip retaining the top cover and removing the latter. All parts should be cleaned in methylated spirits (**FIG 2:39**).

2:23 Fault diagnosis

(a) Leakage or insufficient fuel delivered

- 1 Air vent in tank restricted

- 2 Petrol pipes blocked
- 3 Air leaks at pipe connections
- 4 Pump or carburettor filters blocked
- 5 Pump gaskets faulty
- 6 Pump diaphragm defective
- 7 Pump valves sticking or seating incorrectly
- 8 Fuel vapourising in pipelines due to heat

(b) Excessive fuel consumption

- 1 Carburettor(s) require adjusting
- 2 Fuel leakage
- 3 Sticking controls or choke device
- 4 Dirty air cleaner(s)
- 5 Excessive engine temperature
- 6 Brakes binding
- 7 Tyres under-inflated
- 8 Idling speed too high
- 9 Car overloaded

(c) Idling speed too high

- 1 Rich fuel mixture
- 2 Carburettor controls sticking
- 3 Slow-running screws incorrectly adjusted
- 4 Worn carburettor butterfly valve

(e) No fuel delivery

- 1 Float needle stuck
- 2 Vent in tank blocked
- 3 Pipeline obstructed
- 4 Pump diaphragm stiff or damaged
- 5 Inlet valve in pump stuck open
- 6 Air leak on suction side of pump

CHAPTER 3

THE IGNITION SYSTEM

- 3:1 Automatic timing**
- 3:2 Maintenance. Lucas distributor**
- 3:3 Dismantling**
- 3:4 Reassembly**

- 3:5 AC Delco distributor**
- 3:6 High-tension cables**
- 3:7 Spark plugs**
- 3:8 Fault diagnosis**

The battery-and-coil ignition system is of standard type, but as distributor units of both Lucas and AC Delco make, may be fitted, separate descriptions will be given in regard to detail differences; the principle of operation is however identical.

The ignition timing is controlled in the usual manner by a combination of engine speed and induction manifold pressure. A spring-loaded centrifugal governor advances the ignition as rev/min increases, while a diaphragm influenced by manifold pressure does likewise in conditions of low pressure, i.e. restricted throttle opening; the converse applies in both cases. The governor mechanism turns the contact breaker cam in the direction of rotation as the weights fly outwards against spring tension. The vacuum mechanism has its diaphragm linked to the plate on which the breaker points are mounted, so that pull on the diaphragm under low pressure moves the plate in the opposite direction to that of the cam's rotation. **FIG 3:1** illustrates the component parts of the Lucas assembly, and **FIG 3:2** shows items of the contact breaker above its mounting plate.

3:1 Automatic timing

The combination follows extremely closely the requirements of the engine in all conceivable conditions. When accelerating hard, hill climbing on a wide throttle, and so on, the manifold pressure is high and the vacuum device retards the spark, while fast level-road operation with relatively low throttle opening gives a low absolute mani-

fold pressure (high vacuum) and thus advances the spark. The centrifugal mechanism also retards and advances under these respective conditions, so that little throttle and maximum revs gives maximum advance, and large throttle and minimum revs gives maximum retard.

The two controlling agencies are carefully graded to suit individual types of engine. It is most important in the event of an exchange unit being fitted, to ensure that it is correct, and the engine number should always be quoted when obtaining a replacement.

The vacuum unit does not operate at idling speed, because its control pipe to the induction system is arranged to be cut off when the throttle closes to the idling position; thus the spark remains retarded for starting.

The governor weights have different tensions, so that the action of the weights is fully progressive and in direct proportion to rev/min. Correct movement of the weights is aided by arranging them to follow a definite guided path as they move.

3:2 Maintenance. Lucas distributor

The following applies to the Lucas distributor, and where different treatment is required for AC Delco units, details are given later.

Normal maintenance consists of lubricating the cam with petroleum jelly, and the spindle, governor weights and moving contact-arm pivot with engine oil, every 6000 miles. The cam spindle is oiled by removing the distributor

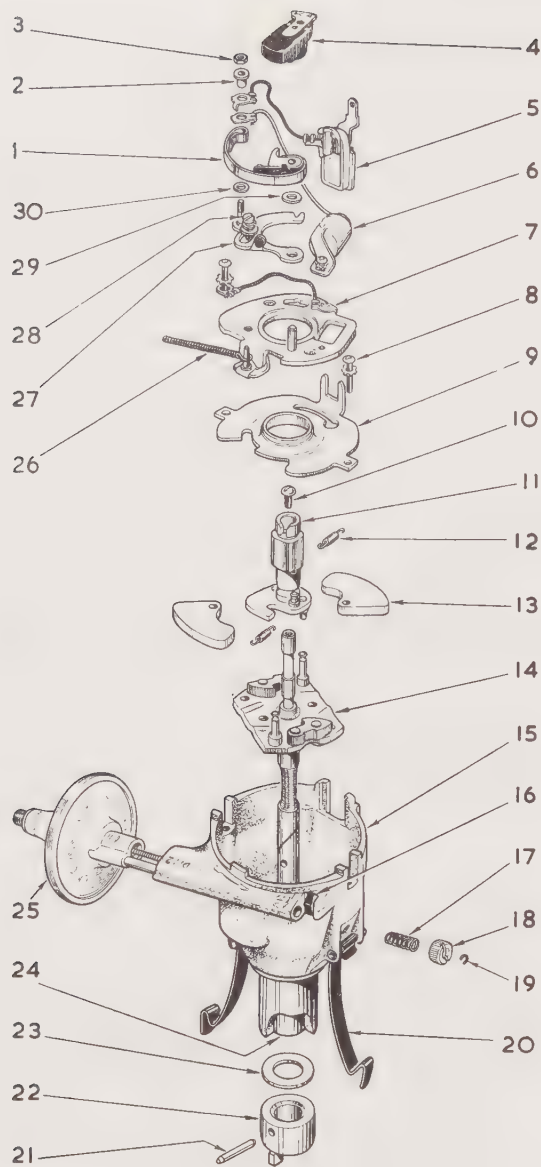


Fig 3:1 Component parts of Lucas distributor assembly. (Tachometer drive not shown).

Key to Fig 3:1 1 Spring contact. 2 Insulating sleeve. 3 Nut. 4 Rotor arm. 5 LT terminal. 6 Capacitor. 7 Contact plate. 8 Screw. 9 Baseplate. 10 Screw. 11 Cam. 12 Centrifugal spring. 13 Centrifugal weights. 14 Action plate and shaft assembly. 15 Distributor body. 16 Ratchet spring. 17 Coiled spring. 18 Adjusting nut. 19 Circlip. 20 Cap retainer. 21 Pin. 22 Driving dog. 23 Washer. 24 Bearing sleeve. 25 Vacuum unit. 26 Vacuum connecting spring. 27 Fixed contact. 28 Screw. 29 Insulating washer. 30 Insulating washer.

rotor as on **FIG 3:2** and applying a few drops of oil to the spindle centre (there being an oil passage round the bolt head). The weights can be oiled through the openings in the breaker base-plate. It is essential not to overdo lubrication, particularly of the cam and contact-arm pivot, as an excess will encourage electrical trouble. To adjust the contact breaker points, the distributor cap and rotor arm are first removed. Then the engine must be turned until the fibre heel of the moving contact is resting on the tip of one of the cam-lobes. The single locking screw which holds the adjustable bracket of the other contact is now slackened.

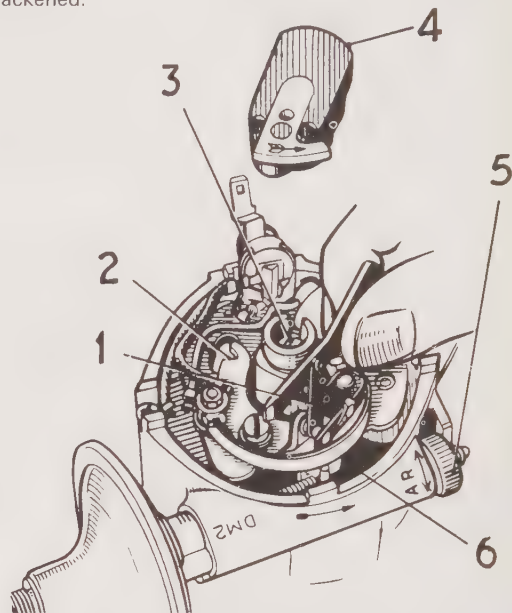


Fig 3:2 Contact breaker assembly with rotor shown removed.

Key to Fig 3:2 1 Gap gauge (0.014–0.016 in). 2 Screw-driver notch for gap adjustment. 3 Oil passage to cam spindle. 4 Rotor arm. 5 Vernier adjustment for timing. 6 Oil hole to centrifugal governor.

The bracket can be moved by means of the slot in its end (the bracket will swing about the moving contact pivot) to obtain the correct gap between the points, which should be 0.014 to 0.016 in. These components are shown clearly on **FIG 3:2**. It is essential that the points are correctly aligned, and meet face-on, and the adjustable contact bracket may be bent slightly to assist this. Having set the gap, tighten the locking screw, and recheck to make sure nothing has moved. When refitting the rotor arm see that the moulded key engages the slot in the top of the cam, and that its lower face abuts firmly on to the register. The distributor cap can then be replaced.

Contact breaker points give no trouble over long periods, and do not require constant dressing. They can however be given attention with a fine emery stone if considered advisable. To remove for this purpose, the distributor rotor is taken off as before, and the moving contact arm can then be detached after unscrewing the terminal nut and removing the nylon bush and condenser lead. The end of the spring can then be pulled off the terminal post,

simultaneously with removing the fibre rocker from its pivot. Note the fibre washers on the terminal and pivot posts.

The detachable contact will come clear after taking out its adjusting screw completely. If the contacts are pitted or badly worn they must be renewed as a matched set. Replacement is largely a reversal of the above procedure. The locking screw in the adjustable contact plate should not be fully tightened until the points have been adjusted. The pivot post for the moving contact must be lightly lubricated before the arm is fitted. Note also that the fibre washers are in position before putting the arm on its pivot, and the spring-end on the terminal post.

The low-tension and condenser leads are next fitted to the terminal post above the spring-end, the nut replaced and securely tightened.

3:3 Dismantling

When difficult starting is experienced from an ignition defect and the contact breaker points show signs of excessive burning, the condenser is likely to be at fault; the burning of points is however the best guide, and condensers need never be replaced unnecessarily through faulty diagnosis. Electrical test equipment is of course available, but probably most owners will have to look for the signs aforementioned. The condenser capacity is 0.18 to 0.25 Mf. It is removed by taking its lead off the terminal post as already described, and then removing the single screw holding it to the breaker baseplate (see FIG 3:1). As the condenser has a definite location on the baseplate, it cannot be refitted wrongly, but make sure that its lead is not trapped, and with no possibility of short-circuiting.

If it is desired to dismantle the complete distributor unit, this must be removed from the engine, having first disconnected the lead from the coil, the primary wire to the contact breaker terminal, and the vacuum pipe from the manifold. The assembly is then withdrawn as described in Chapter 1. FIG 3:1 should be carefully studied when dismantling. The contact breaker points are removed as already described, also the condenser. The tension spring link from the vacuum unit is next unhooked from the plate. Now take out the two screws holding the plate to the body. Remove the low tension terminal at the edge of the plate by sliding it out of its location bracket along with the nylon block and short lead. The plate can then be lifted off. It will be noted that the plate also combines with it the bottom bearing plate on which it rotates for automatic ignition timing. The two portions can be separated by turning the top plate fully anti-clockwise, until the peg enters the opening at the end of the slot in the lower plate. If the spring clip is then disengaged, the two plates will come apart.

The centrifugal governor is now exposed. The weight springs can be unhooked from their pegs on the cam plate, and the screw removed from the top of the shaft above the cam; the cam can then be lifted clear of the weights. The springs are unhooked from the pegs on the action plate, and the weights removed. The shaft assembly is shown on FIG 3:3. This does not show the tachometer drive, which is generally similar to that described later.

The shaft can be removed after driving out the pin retaining the driving dog at the bottom. Note when withdrawing, that there is a distance collar positioned under the action plate.

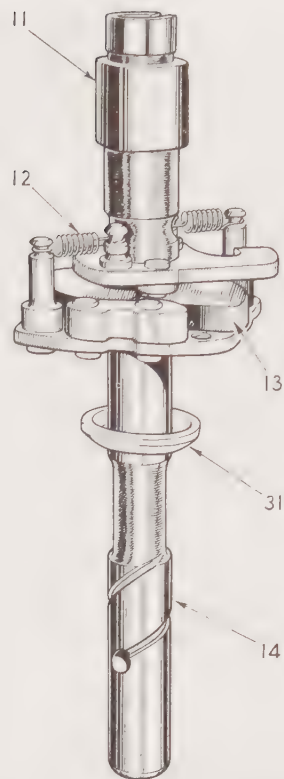


Fig 3:3 Shaft assembly of distributor.

Key to Fig 3:3 11 Cam. 12 Springs. 13 Governor weights. 14 Bearing journal. 31 Collar.

The bearing bush in the main body is of sintered copper-iron, and is of stepped external diameter, the larger diameter extending for 0.75 in from the bottom. If there is excessive wear, the bush can be replaced. Before fitting a new bush, it must be immersed for at least 24 hours in clean engine oil of SAE 30–40 viscosity. The worn bush is pressed out from the body downwards, using a suitably shouldered mandrel. The replacement bush is inserted, smaller diameter first, from the bottom, and will be found to be a push fit until the larger diameter enters the shank. Using the mandrel, the bush is then pressed fully home by any appropriate means that will apply a steady pressure; do not attempt to drive the bush in. The final fit will be tight, and with a slight protrusion at the top end.

After inspecting the shaft for burrs, cleanliness of oil passages, and absence of roughness, it may be reinserted. Ensure that the distance collar and thrust washer are refitted, and re-pin the dog, using a new pin and riveting it firmly in position. The shaft must now be spun round in a suitable rig, such as a lathe or drill adaptor, for about 15 minutes; it should be quite free but without shake after this time. Finally, oil with clean engine oil. It is important that no attempt should be made to enlarge the bush by reaming or other means as this affects the self-lubricating qualities.

End-float on the shaft should not exceed $\frac{1}{32}$ in. If excessive, fit a washer of suitable thickness between the driving dog and the body.

To detach the vacuum unit, the circlip holding the nut at the screwed end of the rod must be removed, and the milled adjusting nut unscrewed; the unit can then be pulled out of the body. Make sure that the main spring and milled nut spring do not get lost, as they may fly out. The diaphragm unit is sealed, and must not be taken apart.

3:4 Reassembly

After checking all parts for wear and cleanliness, first ensure that the spacing washer is correctly placed under the action plate. Next fit the governor weight springs to the pegs on the action plate, and also the weights, with their flat sides abutting the cam ramps and the cutaways nearest to the shaft. Refit the cam, ensuring that it can turn freely; the pegs on the cam are then engaged with the holes in the weights, and the top screws refitted. Next the other ends of the springs are hooked over the pegs in the cam base. Move the cam with the shaft held rigidly to test the action, noting that all the parts move freely, and lightly oil all components of the motion.

The vacuum unit can be refitted or replaced if defective. The adjustment nut, spring, circlip and main spring are replaced as they came off, the nut being turned until there is adequate movement for adjustment in either direction as may be required for variations in quality of fuel. The two parts of the plate assembly can be united, after checking that the moving plate is a good fit without looseness, and that the pivot of the moving contact arm is firm and unworn. The spring clip is sprung over the top edge in the lower plate, the peg of the top plate inserted in the slot in the lower plate, and a slight twist given clockwise, relatively to the plates. The plate assembly can now be put on to the body, and the end of the tension spring of the vacuum unit secured to the lug of the breaker plate. Refit the two holding screws at the body edge. The remaining items are then dealt with as already described.

If it is desired to check the tension of the contact breaker spring, this is done by arranging the points in the closed position by rotating the cam, and using a pull-scale hooked over the breaker arm adjacent to the contact, with a reading taken just as the points separate or increase the tension.

It should be noted that minor changes may be made from time to time in the distributor construction, but these should not affect the requirements for overhaul to any great extent.

3:5 AC Delco distributor

This unit is shown on **FIG 3:4**, and incorporates a drive for the tachometer as shown. Maintenance is generally as described for the Lucas distributor, the centrifugal advance mechanism being lubricated by injecting about a teaspoonful of oil through a hole shown on **FIG 3:5**, adjacent to the condenser. The contact points are adjusted by slackening the screw of the fixed contact, and turning the eccentric adjusting screw to increase or decrease the gap. When correct, the fixing screw is retightened.

To remove the contact breaker after taking off the distributor cap and rotor, the fixed contact screw is first removed, allowing the assembly to be lifted to obtain access to the low tension terminal nut. This nut is taken

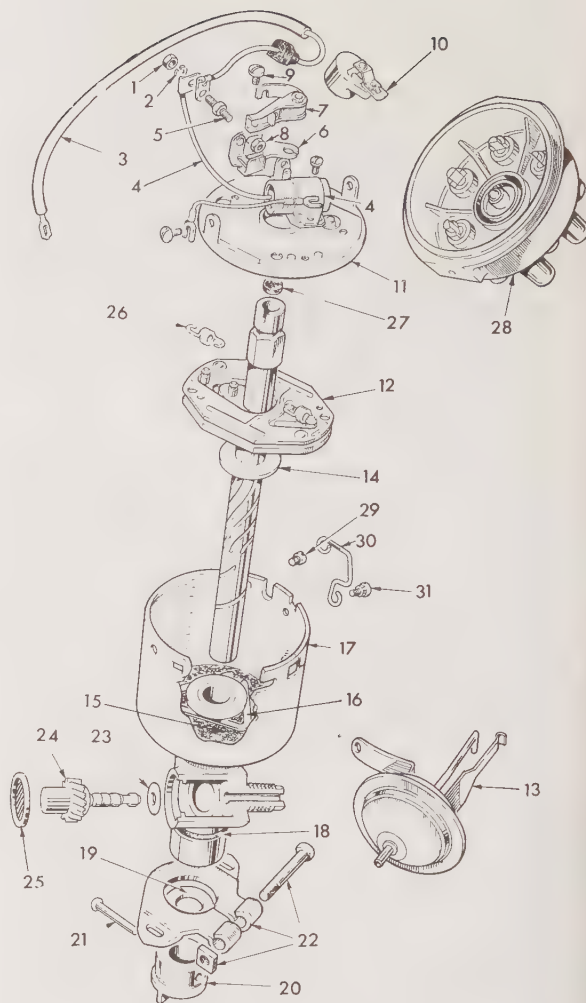


Fig 3:4 Components of AC Delco distributor incorporating tachometer drive.

Key to Fig 3:4 1 Nut. 2 Lockwasher. 3 Low tension cable. 4 Capacitor. 5 Terminal stud. 6 Fixed contact. 7 Moving contact. 8 Nut. 9 Screw (fixed contact). 10 Rotor arm. 11 Contact baseplate. 12 Centrifugal action plate. 13 Vacuum advance unit. 14 Spacer. 15 Oil retaining felt. 16 Felt retaining clip. 17 Distributor body. 18 Oil seal ring. 19 Spacer. 20 Driving dog. 21 Rivet. 22 Clamp plate and bolt. 23 Thrust washer. 24 Tacho. gear. 25 End cover. 26 Spring. 27 Felt plug. 28 Cap. 29 Screw. 30 Cap clip. 31 Setscrew.

off along with the washer and LT wire, and the condenser detached. The fixed and moving contacts can then be removed. For reassembly, the procedure is reversed.

On certain distributors, there is no milled adjusting nut for the static advance setting, while in some other cases the eccentric adjusting screw is omitted from the adjustable contact.

To dismantle the distributor, the details on **FIG 3:4** should be studied. The gear 24 must first be driven out by means of a steel mandrel of 0.22 in diameter, having one

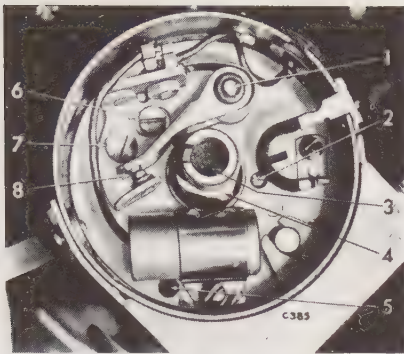


Fig 3:5 AC Delco contact breaker unit.

Key to Fig 3:5 1 Pivot. 2 Oil hole. 3 Oil passage to cam spindle. 4 Cam. 5 Oil hole. 6 Eccentric screw for contact adjustment. 7 Fixing screw for contact plate.

end turned down to 0.15 in diameter by 0.125 in long. Insert this spigot-end into the flexible cable attachment end of the gear housing, and drive out the gear, thrust washer and end cover (Nos. 24, 23 and 25).

Remove of the pin from the driving dog will allow the main-shaft to be removed as detailed for the Lucas type. When reassembling, the felt ring 15 must be soaked in clean engine oil, shaking off the surplus before fitting. Note that the driving dog must be re-pinned to the shaft with its tongue offset to the left when facing the slot for the rotor arm at the top of the shaft. The shaft end-float, measured between the washer and housing should be 0.002 to 0.005 in.

Before refitting the tachometer drive gear, smear the components all over with petroleum jelly. Push the gear into position, fit a new end-cap 25, and retain this by lightly peening over the body in four equally-spaced positions.

3:6 High-tension cables

The HT cables are of a quality which discourages deterioration. However if renewal is required at any time, it should be particularly noted that the cables are of a resistive pattern, of approximately 420 Ohm per in (2.5 cm), interference suppression being effected by a conducting medium comprising carbon-impregnated cotton or nylon cording. It is essential that replacements are correct, and that ordinary copper cables are not used. A serviceable cable should give a reading of 3000 to 12,000 Ohm resistance.

The cables are attached to the distributor head by screws as shown on **FIG 3:6**. If replacements are called

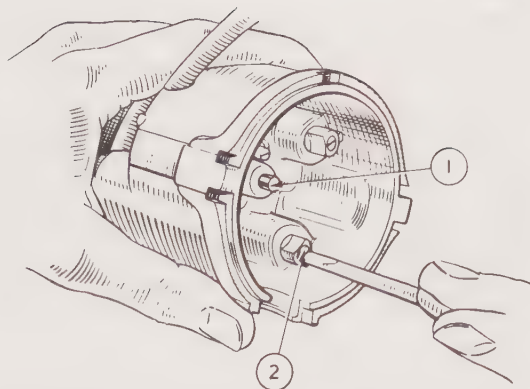


Fig 3:6 Method of attaching or releasing high-tension cables from distributor cap.

Key to Fig 3:6 1 Centre carbon brush. 2 Contact and cable fixing screw.

for these must be cut to the appropriate length for the cylinder firing order, and replaced in that order (**FIG 3:7**). Before replacing therefore, it is advisable first to measure the new cables against the ones to be removed, and clearly identify their positions by tags. Always obtain replacement cables from an approved agent, as this will ensure obtaining the high-resistive type.

3:7 Spark plugs

With an engine in good condition, the standard spark plugs have a perfectly adequate heat range to cater for all eventualities. Thus, plug trouble must not be put down to the use of an unsuitable grade, nor attempts made to cure it by haphazard substitution. Other causes should first be looked for, such as mixture derangement, excess of lubricant in the combustion chambers, or too great a working temperature due to defective water circulation, faulty ignition timing, pre-ignition, and so on. The recommended plugs for all engines are stated in the Appendix. Overheating of spark plugs should be treated seriously, as it means that the whole combustion chamber is overheated and this can lead to piston and valve troubles. In order that the plugs themselves should have an effective heat path, they should always be tightened adequately but not excessively, and their washers kept in good condition.

As research into plug operation is continuous, and improvements are made regularly, it is advisable to ensure that the current recommendations are always in use, so as to obtain maximum performance as well as economy. The latest types are likely to operate without trouble for considerably greater mileages than was the case in the recent past.

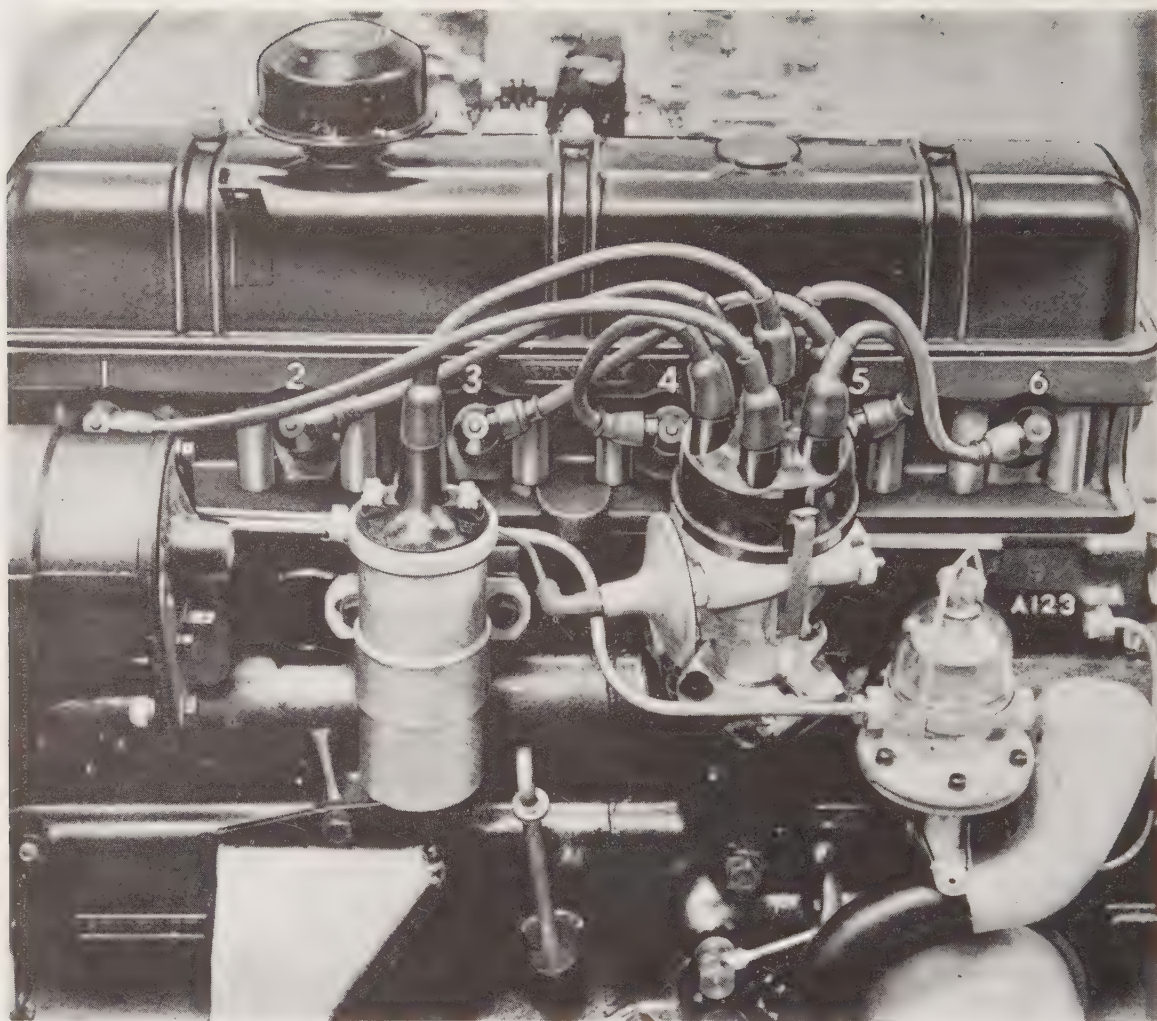


Fig 3:7 Attachment sequence of high-tension cables on 6-cylinder engine.

3:8 Fault diagnosis

(a) Engine will not fire

- 1 Battery discharged
- 2 Distributor points dirty, pitted or out of adjustment
- 3 Distributor cap dirty, cracked or 'tracking'
- 4 Carbon brush inside distributor cap not in contact with rotor
- 5 Faulty cable or loose connection in low-tension circuit
- 6 Distributor rotor arm cracked
- 7 Faulty coil
- 8 Broken contact breaker spring
- 9 Contact points stuck open

(b) Engine misfires

- 1 Check 2, 3, 5 and 7 in (a)
- 2 Weak contact spring
- 3 High-tension coil and spark plug leads cracked or perished
- 4 Spark plug loose
- 5 Spark plug insulation cracked
- 6 Spark plug gap incorrect
- 7 Ignition timing too far advanced

CHAPTER 4

THE COOLING SYSTEM

- 4:1 Maintenance
- 4:2 Flushing
- 4:3 Filler cap

The cooling water circulation is by thermo-syphon, assisted by a belt-driven pump which is attached to the front of the cylinder block. The flow of water is from the radiator base to the pump intake, thence into the block and up around the cylinder head combustion chambers and valve seats, emerging by way of an outlet containing a thermostat unit, to the top of the radiator. On some cars a water-heated induction manifold is incorporated in the circulation system, as typified by **FIGS 1:13** and **1:14**, and in all cases connections for a car heater are available. The radiator core has its air flow augmented by a fan which is mounted on the pump shaft on four-cylinder engines and on the crankshaft nose on six-cylinder types. When the coolant is cold, the thermostat is closed but incorporates a bypass which allows a slow circulation for rapid warming up of the water in the block and head. A sensing element for the water temperature gauge (when fitted) is screwed into a boss on the thermostat housing as shown on **FIG 4:1**.

4:1 Maintenance

Little maintenance is called for on the cooling system, apart from periodic checking of the belt tension and the water level; the latter is not necessary on engines which have a sealed cooling system with overflow bottle, as shown on **FIG 4:2**. When inspecting the water level, the filler cap must never be removed quickly when the water is hot, as the system is under pressure. Topping-up is only necessary to a level coincident with the bottom of the filler neck. If plain water is used, the diluting effect on an anti-freezing mixture must be taken into account. Belt tension is correct with a side movement on the longest run of the belt, of no more than about 0.75 in (19 mm) total. The method of adjustment as shown on **FIG 4:3** is by

- 4:4 Thermostat
- 4:5 Water pump
- 4:6 Fault diagnosis

means of the slotted generator bracket; tighten all nuts and bolts firmly after adjusting. Draining taps or plugs are provided on the radiator and the cylinder block; the filler cap should be removed when draining, to prevent any chance of air-locks. Approved anti-freeze mixtures contain inhibitors which keep the system clean and free from corrosion, and for this reason, it is recommended that when the coolant shows signs of becoming cloudy or dirty, the mixture should be drained, the system flushed with clean water, and a new anti-freeze coolant supply introduced. When filling the system, after closing the drain taps the heater control should be set to the 'hot' position. When the engine is warm and the water under pressure, this can be relieved by turning the filler cap slightly to loosen it, without disengaging from the filler neck; this will release the pressure and the cap may then be removed altogether. Make sure that draining is complete, by skewering the tap or plug orifices to remove any sediment or foreign matter.

4:2 Flushing

If it is desired to flush through the system, it is as well to remove the drain taps completely. Before flushing, let the engine cool down, if it is at working heat. When the cooling water has drained off, run fresh water from a hosepipe into the filler neck for a period of 15 minutes or so. When the radiator is seriously choked, it is often possible to clear the tubes by removing the filler cap and bottom hose connection, and forcing water from a hosepipe into the bottom stub, using a suitable adaptor on the hosepipe so as to obtain adequate water pressure (see **FIG 4:4**). Provision must of course be made to deal with the waste water emerging from the filler neck, to ensure that it does

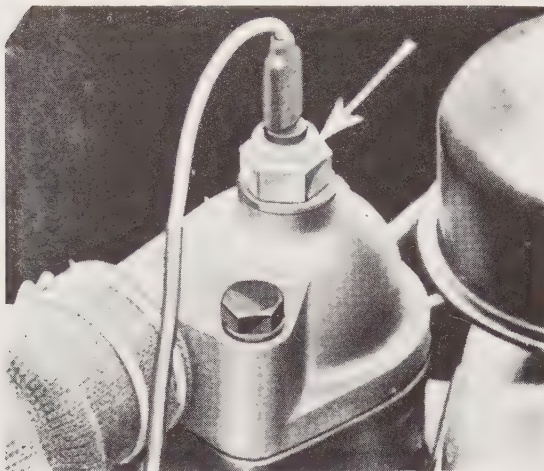


Fig 4:1 Location of sensing element for water temperature gauge.

not flood over the engine. This reversal of the normal flow will often dislodge a lot of foreign matter without more drastic measures.

It may still be advisable in some cases to refill with a cleaning solution, this being drained off after a prescribed period of running. After use, the system should again be flushed. Only reputable cleaning compounds should be used, and the instructions as to their use strictly adhered to.

4:3 Filler cap

In order to retain pressure in the system but at the same time to allow air to enter as the engine cools, the filler cap is spring-loaded to provide both a pressure and a vacuum seal; this is shown on **FIG 4:5**. On sealed systems, the pressure release pipe is led into a container (**FIG 4:2**) instead of draining to waste; in this way any coolant expelled into the bottle is drawn back into the system as the temperature falls.

Service stations have a device available for testing the filler-cap seal, as shown on **FIG 4:6**. The cap, after thoroughly cleaning, is fitted to the neck of the tester, and pressure is pumped up by means of the bulb, until the

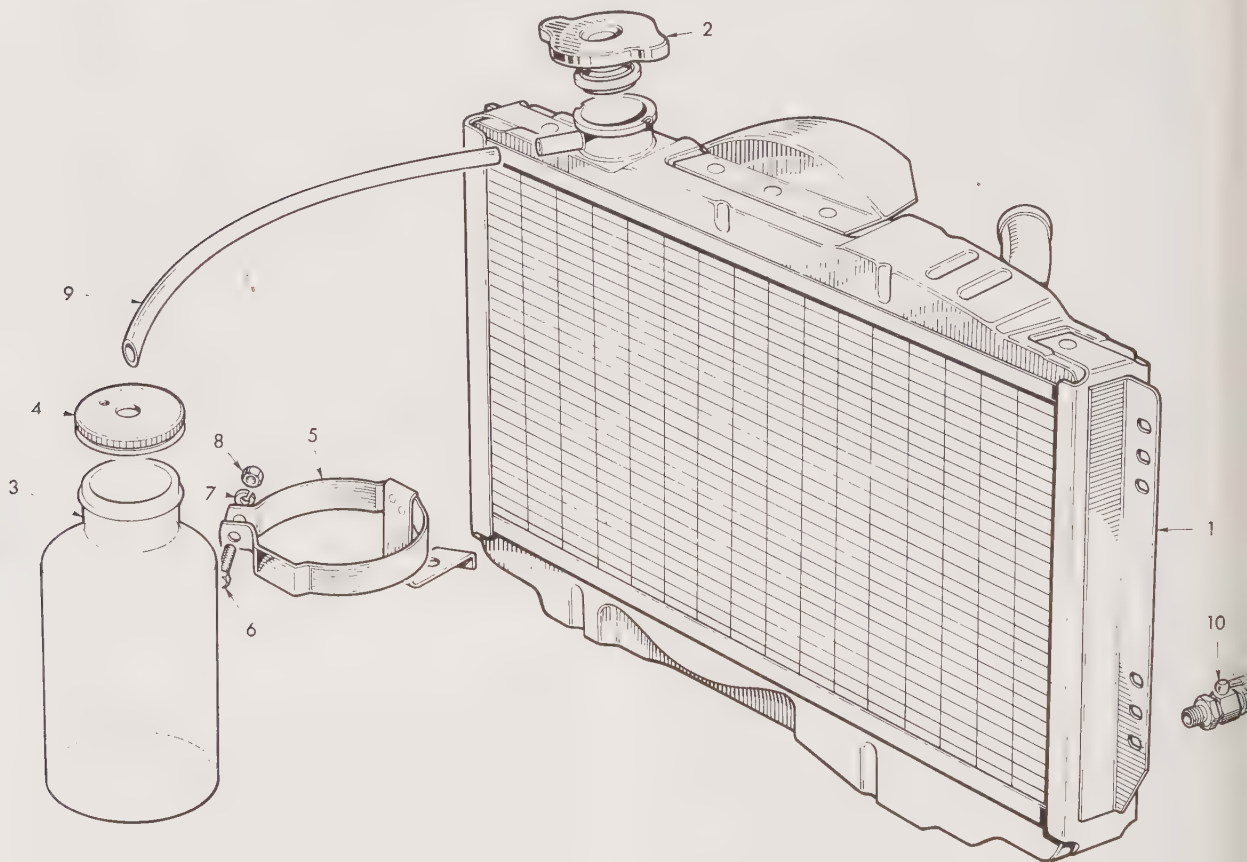


Fig 4:2 'Spitfire' radiator with overflow bottle

Key to Fig 4:2 1 Radiator block. 2 Filler cap. 3 Overflow bottle. 4 Cap. 5 Strap. 6 Screw. 7 Spring washer. 8 Nut. 9 Overflow pipe. 10 Drain tap.

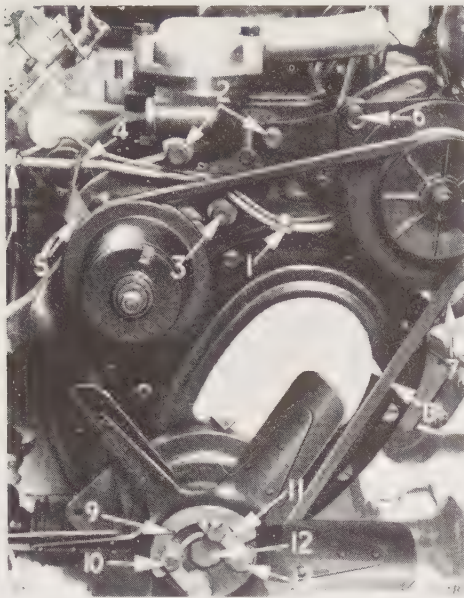


Fig 4:3 Water pump and generator drive and associated parts, on 6-cylinder engine.

Key to Fig 4:3 1 Pipe clip. 2 and 3 Pump fixing bolts. 4 Pipe grommet. 5 Pipe bracket. 6 Generator belt adjustment. 7 Generator pivot bolts. 8 Belt slack ($\frac{3}{4}$ in or 19 mm). 9 Fan balance weights. 10 Fan bolt. 11 Lockplate. 12 Crankshaft end-bolt. 13 Fan bolt.



Fig 4:4 Hosepipe adaptor for radiator flushing

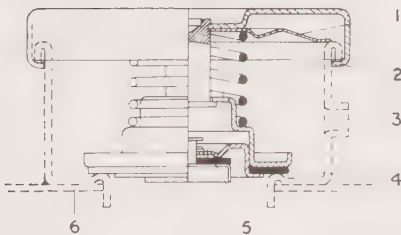


Fig 4:5 Section of radiator filler cap.

Key to Fig 4:5 1 Friction plate. 2 Retaining lugs. 3 Pressure release pipe. 4 Pressure valve seal. 5 Vacuum valve seal. 6 Header tank.

gauge pointer stops moving. The gauge should register a pressure of 7 lb/sq in (0.492 kg/cm²) and hold this for ten seconds. If this is not possible, the cap must be replaced.

4:4 Thermostat

The thermostat may be removed after draining the system, by detaching the water outlet casting cover, and lifting out the thermostat as shown on **FIG 4:7**. If it is desired to test for correct operation, the thermostat should be immersed in water having a thermometer therein to register the temperature (**FIG 4:8**). On heating the water, the valve should commence opening, and the temperature at which this happens should be noted, as follows:

Opening temperature 79.5–83.5°C. Fully open at 93.5–96°C. Minimum valve lift 0.312 in (7.925 mm). Maximum valve lift 0.875 in (22.225 mm).

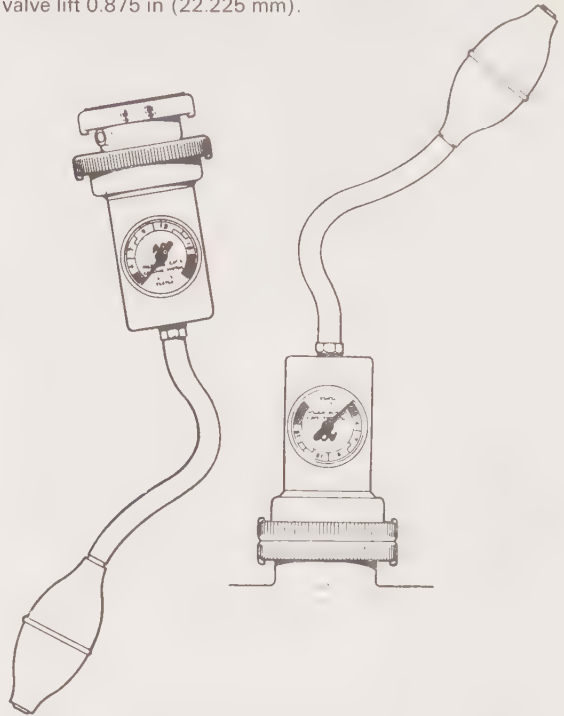


Fig 4:6 Testing instrument for filler cap, used as explained in text.

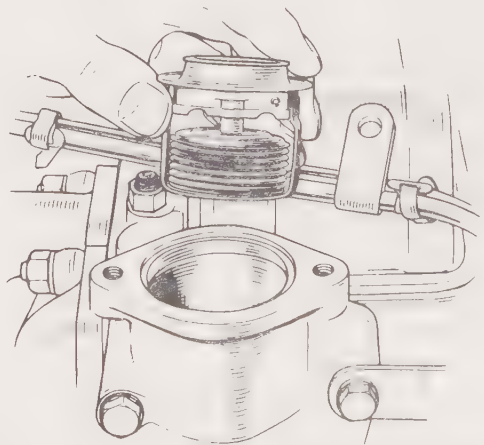


Fig 4:7 Removing thermostat unit from housing.

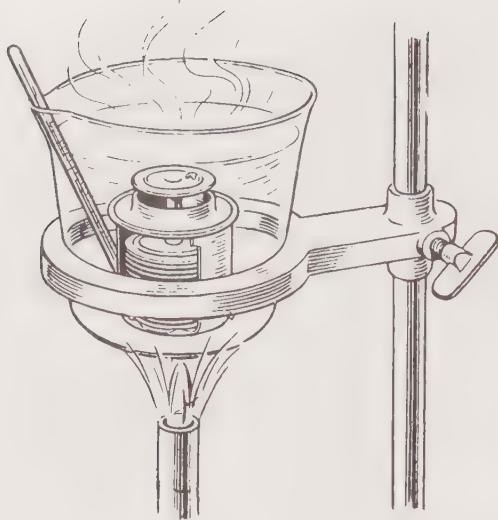


Fig 4:8 Testing thermostat in hot water at known temperature.

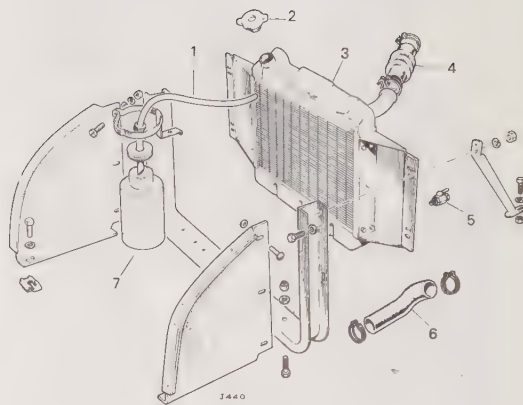


Fig 4:11 'Spitfire' Mk. 3 radiator and attachments.

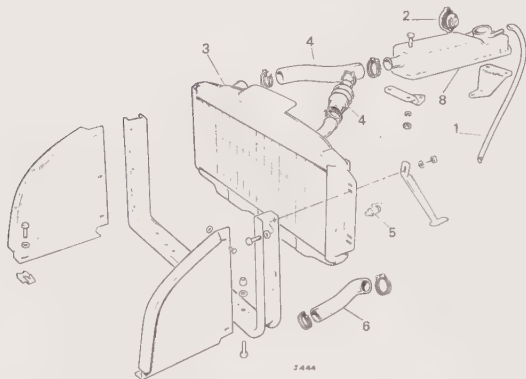


Fig 4:9 'Spitfire' radiator and attachments (up to FC 39925).

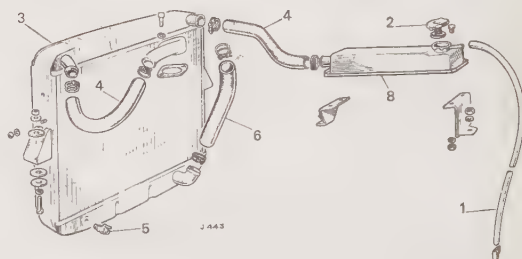


Fig 4:12 'Vitesse' radiator and attachments (up to HB 26149).

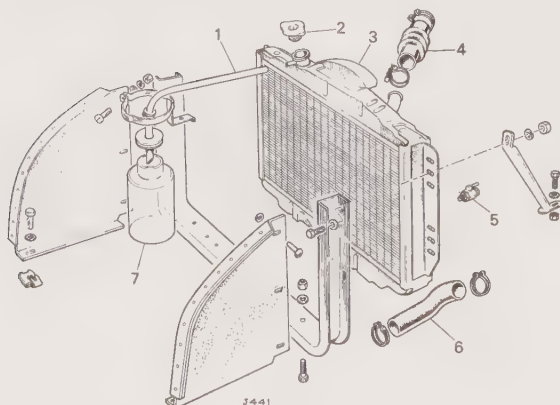


Fig 4:10 'Spitfire' radiator and attachments (from FC 39926) and 'Spitfire' Mk. 2.

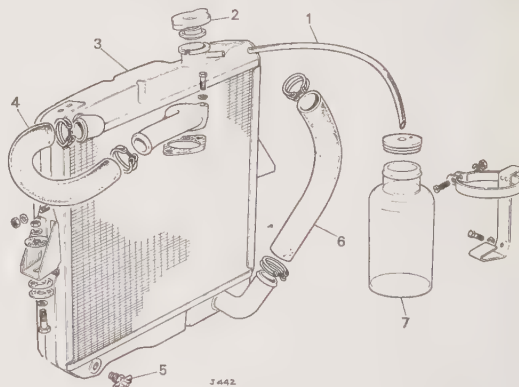


Fig 4:13 'Vitesse' radiator and attachments (from HB 26149).

Key to Figs 4:9 to 4:13
 1 Overflow pipe. 2 Filler cap.
 6 Bottom hose. 7 Overflow reservoir. 8 Header tank.

3 Radiator. 4 Top hose(s). 5 Drain cock.

Replacement of the thermostat unit in its housing is a reversal of removal; make sure that it is located properly, and that the flange washer is in good condition when the water outlet is refitted; tighten the nuts evenly to a torque of 16–18 lb/ft.

The radiator may be removed after taking off the hoses and undoing the attachments, as typified by **FIGS 4:9 to 4:13** inclusive. There may be packing pieces on the latter and these must be positioned correctly when refitting. The radiator can be cleaned externally by means of a brush and high-pressure air-blast, but at all times when off the car, take care that the matrix is not damaged. It is not necessary to take off the radiator to remove the water pump.

4:5 Water pump

The pump is shown in section on **FIG 4:14**, while **FIG 4:15** gives details of the components. Note that the fan components shown apply only to four-cylinder engines. The pump body is attached to the front of the engine block as shown on **FIG 4:3**. To remove, after draining the cooling system and disconnecting the battery, the generator bracket attachments should be slackened and the generator swung as far inwards as possible, which

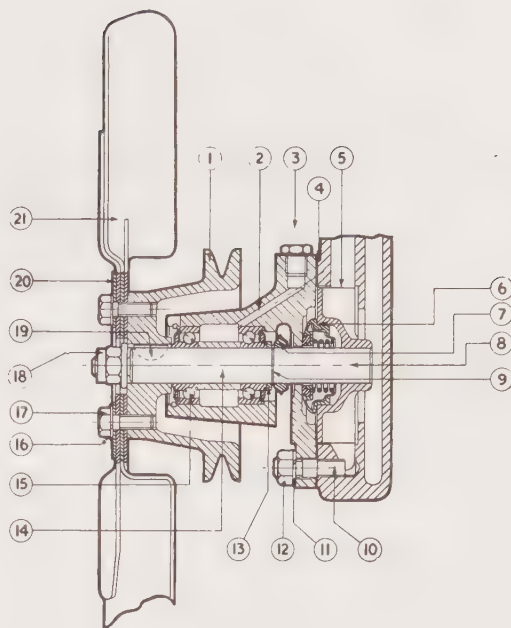


Fig 4:14 Sectional view of water pump. (Fan is not fitted to pump on 6-cylinder engines.)

Key to Fig 4:14 1 Fan pulley. 2 Bearing housing. 3 Plug. 4 Water pump body. 5 Impellor. 6 Sealing gland. 7 Rubber ring. 8 Spindle. 9 Circlip. 10 Stud. 11 Spring washer. 12 Nut. 13 Washer. 14 Distance piece. 15 Bearings. 16 Spring washer. 17 Bolt. 18 Nyloc nut. 19 Woodruff key. 20 Balance weight. 21 Fan blade assembly.

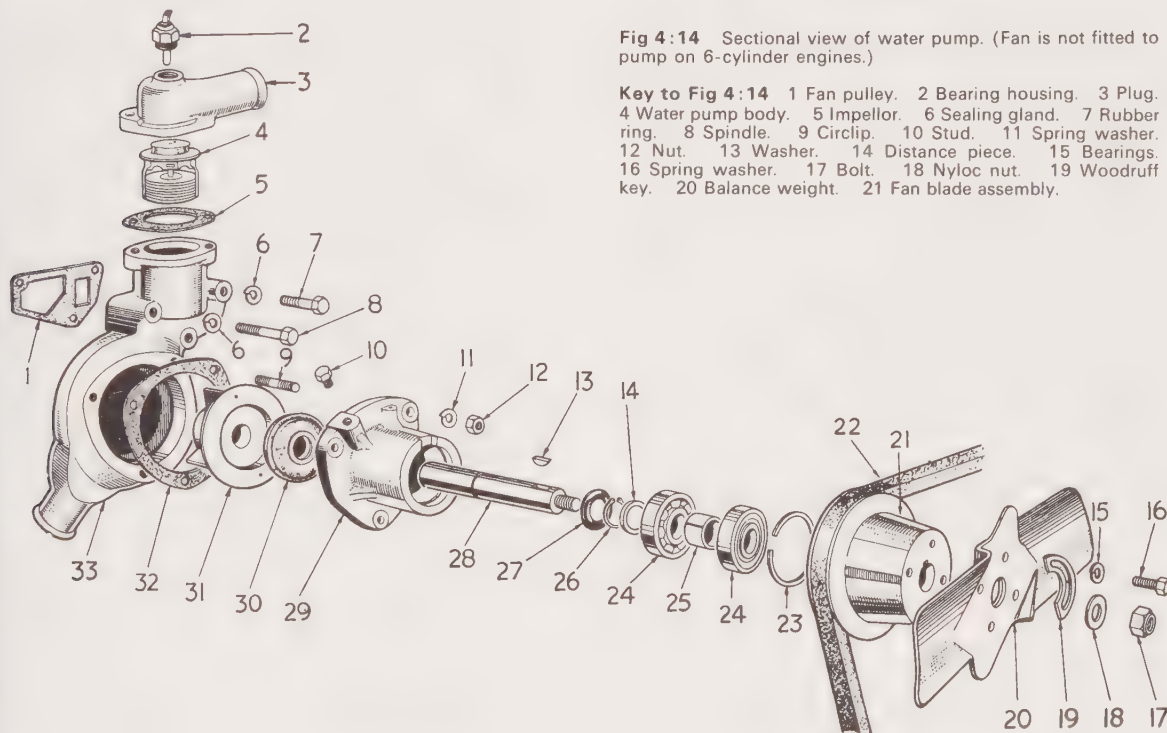


Fig 4:15 Components of water pump. (Fan is not fitted to pump on 6-cylinder engines.)

Key to Fig 4:15 1 Gasket—body to cylinder head. 2 Temperature transmitter. 3 Top elbow. 4 Thermostat. 5 Gasket—elbow to body. 6 Spring washer. 7 Bolt. 8 Bolt. 9 Stud. 10 Grease plug. 11 Spring washer. 12 Nut. 13 Woodruff key. 14 Distance piece. 15 Spring washer. 16 Setscrew. 17 Nyloc nut. 18 Plain washer. 19 Fan balancer. 20 Fan. 21 Pulley. 22 Driving belt. 23 Circlip. 24 Ball race. 25 Distance piece. 26 Circlip. 27 Spinner. 28 Spindle. 29 Bearing housing. 30 Seal assembly. 31 Impeller. 32 Gasket. 33 Body.

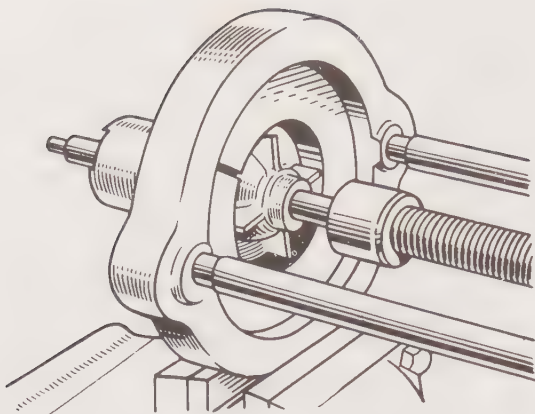


Fig 4:16 Use of special drawer to remove pump impeller.

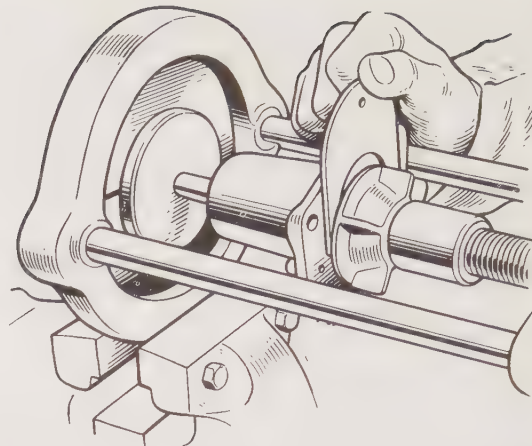


Fig 4:17 Use of spacer-gauge when refitting pump impeller to spindle.

will allow the belt to be taken off the pulleys. Remove the hoses and also the temperature transmitter wire if a sensing element is fitted. The three securing bolts can then be withdrawn and the pump removed, complete with the fan if fitted.

If leakage is experienced, the simplest remedy is to replace the complete pump with a serviced exchange assembly. However, for those with the necessary equipment, it is quite feasible to dismantle the unit and renew any defective parts.

Referring to **FIG 4:15**, the outer endcover is secured by the bolts attaching the pump to the cylinder block, and can be separated from the pump casing by one or two smart blows. The endcover contains the shaft and bearing assembly along with the impeller. To separate these items, the shaft end-nut must be removed, and the fan blades detached if fitted. Carefully lever off the pulley, taking care to retrieve the shaft key. The impeller can only be removed by using a suitable drawer as shown on **FIG 4:16**, the type indicated being Churchill tool No. FTS127/S4221A. The seal assembly, located in the boss of the impeller, can next be taken off (see **FIG 4:15** for position of all these items).

To take the spindle assembly out of the housing, remove the circlip at the pulley end of the housing which locates the outer race of the ball bearing, and drive out the shaft complete with its bearings, using a copper drift from the impeller end of the shaft. The two ball bearings require careful removal, using a press or tubular drift which does not damage the races; the remaining items are readily slid off, note being taken of the sequence in which these must be reassembled. Having cleaned the endcover and bearing housing, the gland sealing face should be inspected. If this is scored or damaged in any way, it must be expertly recut using Churchill tool No. S.126; this can be done by any Triumph agent. The final depth of the gland face from the housing flange face must not exceed 0.265 in (6.7 mm).

A new seal assembly must be fitted, and any other parts such as bearings should be carefully inspected after washing out the grease. Renew if there is any doubt about their serviceable condition.

To reassemble, first pack the bearings with fresh grease,

and fit them to the shaft along with the associated items, remembering that there is a distance tube between the two races. The sealed faces of the bearings must face outwards. Replace the shaft and bearing assembly in the housing, using a tubular drift of correct size, and fit the large circlip into the housing groove so that the adjacent bearing locates firmly against it. Thoroughly clean the impeller, and fit the new seal assembly into the central recess so that it is absolutely true all round. The impeller may now be pressed back on to the shaft. When doing this, a spacer having a thickness of 0.030 in (0.762 mm) must be inserted between the mounting flange and the impeller as shown on **FIG 4:17**, so as to ensure the correct running clearance. When the impeller is positioned correctly, apply a little solder to the shaft end and the surrounding impeller boss, so as to prevent leakage. The shaft key may then be fitted, the pulley pressed on, and all remaining items assembled. The shaft end-nut should finally be tightened to a torque of 14–16 lb/ft, noting that the nut is of Nyloc (stiff) type.

When replacing the endcover assembly on the pump body, ensure that the flanges are clean, and use a new gasket if the old one is damaged. The pump may then be refitted to the cylinder block, tightening the three bolts to a torque of 18–20 lb/ft. Replace the drive belt, and tighten in accordance with particulars given earlier.

4:6 Fault diagnosis

(a) Internal water leakage

- 1 Cracked cylinder wall
- 2 Loose cylinder head nuts
- 3 Cracked cylinder head
- 4 Faulty head gasket
- 5 Cracked tappet chest wall

(b) Poor circulation

- 1 Radiator core blocked
- 2 Engine water passages restricted
- 3 Low water level
- 4 Loose fan belt

- 5 Defective thermostat
- 6 Perished or collapsed radiator hoses

(c) Corrosion

- 1 Impurities in the water
- 2 Infrequent draining and flushing

(d) Overheating

- 1 Check (b)

- 2 Sludge in crankcase
- 3 Faulty ignition timing
- 4 Low oil level in sump
- 5 Tight engine
- 6 Choked exhaust system
- 7 Binding brakes
- 8 Slipping clutch
- 9 Incorrect valve timing
- 10 Retarded ignition
- 11 Mixture too weak

CHAPTER 5

THE CLUTCH

- 5:1 Operation
- 5:2 Maintenance
- 5:3 Main cylinder
- 5:4 Operating cylinder

- 5:5 Clutch dismantling
- 5:6 Pressure unit
- 5:7 Release bearing
- 5:8 Fault diagnosis

The clutch is of the single dry-plate type, the driven plate incorporating a spring-cushioned hub and linings flexibly mounted to ensure smooth take-up. The construction is as normal practice, with the plate free to slide on splines on the gearbox input shaft, this shaft locating in a spigot bearing at the flywheel centre. The pressure unit comprising cover, springs, release levers and pressure plate, is obtainable and serviced as an assembly; no useful purpose is gained by dismantling it, since special gauges, etc., are required to ensure correct setting-up. The rear face of the flywheel forms the opposite contact surface relative to the pressure plate, the driven plate being sandwiched between them.

5:1 Operation

The release mechanism comprises a hydraulic master cylinder operated by a suspended pedal, the cylinder being flexibly piped to an operating cylinder mounted on the clutch housing. This non-mechanical connection ensures that engine movement is not felt at the pedal. The operating cylinder piston operates a push-rod, acting on the end of the clutch release arm which pivots on a fulcrum inside the housing. Clutches fitted to later cars have a single spring of diaphragm type instead of the multiple-coil spring system, but this does not affect the withdrawal

principle. Reference should be made to **FIGS 5:1** and **5:2** for details of the assemblies.

It should be noted that the method of pivoting the release arms differs considerably, but in all cases on actuation the arm presses on a ball-thrust release bearing to operate the clutch release levers at the pressure unit. This action withdraws the pressure plate, and thus frees the driven plate. On the diaphragm-spring type, there are no clutch release levers, and the thrust bearing presses against the spring centre for the same effect.

Since the hydraulic fluid can never be pressurised except when the clutch is withdrawn, the load on the thrust bearing in normal running is never more than a harmless light contact. The dismantled components and withdrawal mechanism are shown on **FIG 5:3**.

The only maintenance normally required is to keep the fluid reservoir topped up to the correct level and to ensure that the adjustment on the operating cylinder gives the necessary free movement. When the pedal is moved through the whole of its return travel, there is a clearance between the operating cylinder push-rod and the release arm, this being inherent in the system.

The fluid level should be kept within about $\frac{1}{2}$ in of the top face of the reservoir, which is integral with the body of the hydraulic cylinder. Take care not to allow dirt to enter with the fluid, and always ensure that the air-vent in the filler cap is clear, and the cap firmly in place.

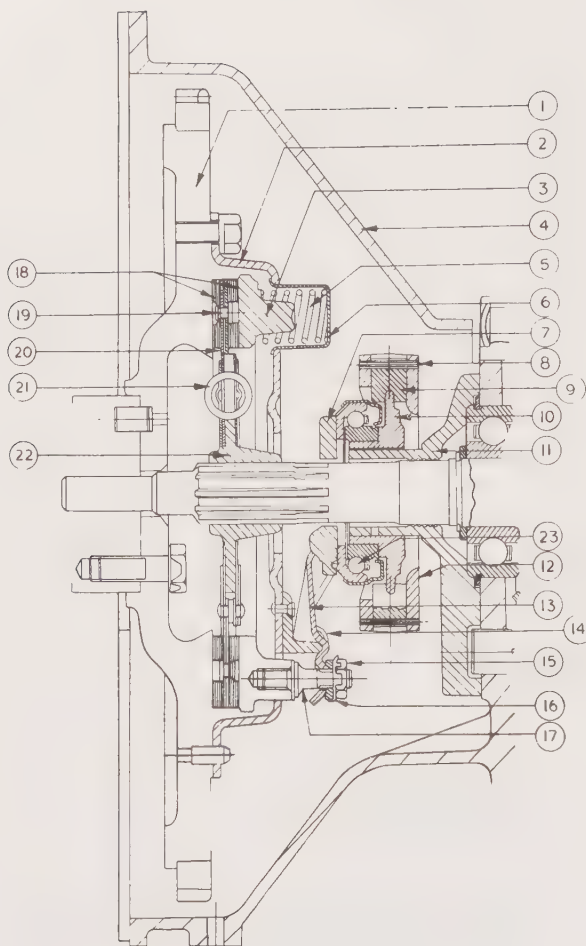


Fig 5:1 Section of typical coil-spring clutch, as fitted to earlier 'Spitfire'.

Key to Fig 5:1 1 Flywheel. 2 Cover pressing. 3 Pressure plate. 4 Clutch housing. 5 Thrust springs. 6 Spring cups. 7 Release lever plate. 8 Retaining pin. 9 Thrust plug. 10 Bearing sleeve. 11 Front cover. 12 Crossmember. 13 Release lever. 14 Anti-rattle spring. 15 Adjusting nut. 16 Lock plate. 17 Stud. 18 Friction lining. 19 Rivet. 20 Clutch disc. 21 Damper spring. 22 Clutch hub.

5:2 Maintenance

The system should not require bleeding unless components have been dismantled. However, a bleed valve is provided for this purpose on the operating cylinder at the end remote from the push-rod, and this is opened by turning it anti-clockwise; the valve can be seen at the right-hand end of the cylinder, on **FIG 5:4**. To exclude all air from the system, a tube is first attached to the valve and led into a container containing fluid. The valve is then opened, the container filled, and the pedal operated several times in slow motion so that fluid is pumped right through from the reservoir to the jar. When the fluid entering the jar is seen to be free from air bubbles the bleed valve can

be closed and the tube and jar removed. Fresh fluid should of course be used at all times for topping up the reservoir.

The hydraulic master cylinder is mounted on the engine side of the bulkhead, on a pressed steel bracket as shown on **FIG 5:5**, and is operated by a pendant pedal pivoted on another bracket inside the car. The cylinder is open at one end, except for the rubber boot cover where the piston and push-rod assembly is entered. At the opposite (blank) end of the cylinder are the integral fluid reservoir, and the union for fluid delivery to the clutch operating cylinder. The cylinder is shown in section on **FIG 5:6**.

The piston has a spigot at its front end to receive a valve-stem, and also carries the retainer for a compression spring which serves to return the piston to the start of the stroke after pedal operation. (The pedal itself also has its own return spring.) Reference to **FIG 5:7** will show that the large spring has a spacer or distance piece at its front end. At the end of the valve stem is a seal-type valve backed by a 'bent' washer; the action of the components is as follows.

When the clutch is fully home in the driving position, the clutch pedal is completely released. The push-rod 9 is held against the stop 12 by the return spring on the pedal. The plunger 7 moves rearwards under pressure from the spring 5. The flange at the end of the valve shank 4 moves into contact with the spring retainer 6, and on rearward movement continuing, the shank 4 pulls the seal 1 from its seating on the end of the cylinder bore, compressing the 'bent' spring washer 2. Hydraulic fluid can then flow from the reservoir past the seal and distance piece and into the cylinder. Fluid can also flow in the reverse direction if necessary; the significance being that the pressures are precisely balanced in the cylinder and reservoir, and can never exceed that of the atmosphere.

When the pedal is depressed to withdraw the clutch, the first movement of the push-rod 9 and plunger 7 will release the valve shank 4 and allow the bent washer 2 to press the valve against the seating. Thus communication between the reservoir and cylinder is cut off, and any continuance of pedal movement pressurizes the fluid and forces it through the delivery union and pipe to the clutch operating (slave) cylinder. It will be appreciated that when in use, and assuming the system is in good condition and leak-proof, no fluid is actually consumed; the reservoir simply serves to preserve a pressure balance and prevent leakage of air and air-locks, by forming a hydraulic seal.

The rubber boot fitted over the main push-rod at the open end of the cylinder prevents the entry of dirt and moisture. At the same time the open-ended construction makes dismantling a simple matter should components require replacement due to leakage and loss of pressure.

5:3 Main cylinder

To dismantle the master cylinder, first pull back the rubber boot and take out the clevis pin which holds the push-rod to the pedal. Have a suitable blanking plug ready for insertion in the delivery union of the cylinder; unscrew the union nut, detach the pipe and fit the blanking plug to prevent dirt entering. Take off the bolts from the cylinder mounting flange, and withdraw the cylinder from the bulkhead bracket. Then empty the fluid from the reservoir.

Remove the rubber boot at the cylinder open end, take out the circlip from the groove in the bore, remove the

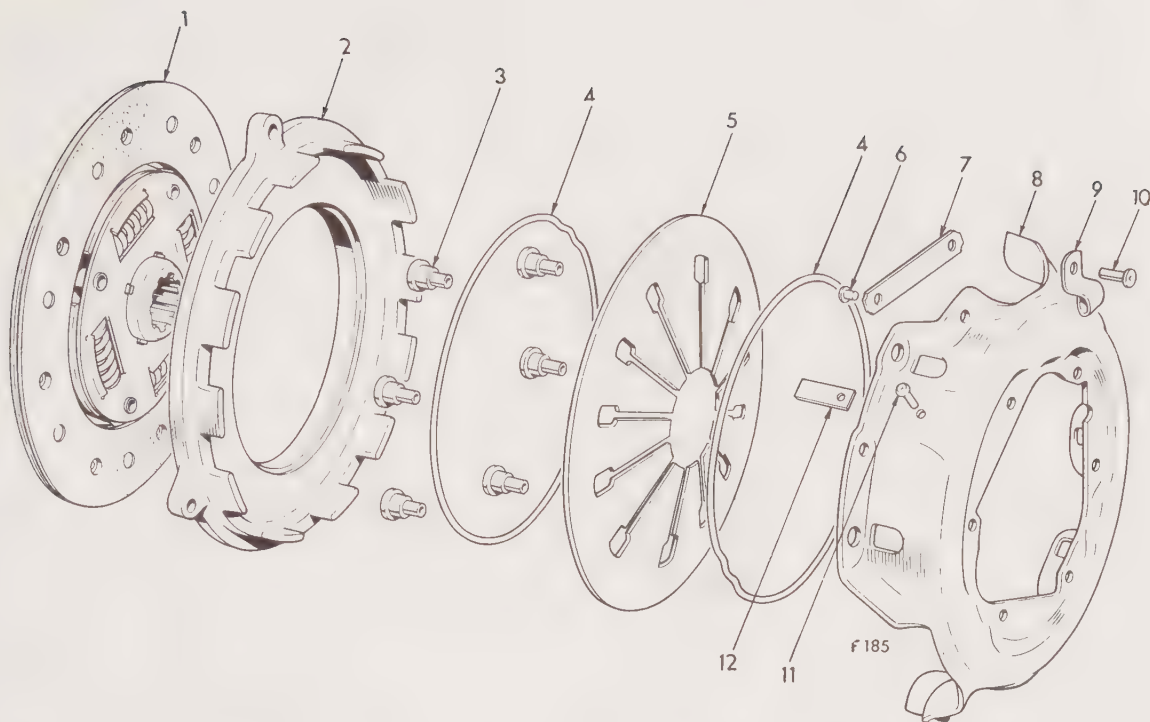


Fig 5:2 Components of diaphragm-spring clutch as fitted to all later cars.

Key to Fig 5:2 1 Driven plate. 2 Pressure plate. 3 Rivet. 4 Fulcrum ring. 5 Diaphragm spring. 6 Rivet. 7 Drive strap. 8 Cover pressing. 9 Retaining clip. 10 Rivet. 11 Rivet. 12 Balance weight.

push-rod and then the piston and valve assembly. The piston is next detached from the valve assembly. Prise up the tab which holds the spring retainer in position on the front end of the piston (and which fits under a shoulder on the front of the piston) by using a screwdriver. Then remove the retainer, spring, and valve assembly from the piston.

The valve assembly is dismantled by compressing the spring and moving the stem to one side in the retainer, this action releasing it through the keyhole slot in the retainer end. The valve seal and also the piston seal can then be removed if defective.

All parts should be cleaned, using no liquid other than brake fluid at any time; this is most important. Inspect all parts carefully for damage or wear; in particular, note the condition of the lip on the piston seal, but do not distort the seal when examining. To reassemble the master cylinder, first replace the piston seal, with its lip facing down the cylinder, in the direction of pressure. Also fit the valve seal, lip outwards and away from the spring. Next the bent shim, spacer (legs over the valve seal) and spring are fitted in that order over the stem. Make sure that the valve stem flange is contacted by the convex face of the shim. The retainer can then be fitted in the end of the spring. Compress the spring, fit the valve stem into the keyhole slot and locate it.

Now insert the piston front end into the retainer, securing it by fitting the retainer tab under the piston front shoulder.

After dipping in hydraulic fluid, the assembly can be inserted in the cylinder; use great care to ensure that the lip of the piston is not damaged on entry, and ease it gently into the bore. Fit the main push-rod and rubber boot. This completes the assembly.

The master cylinder can then be replaced on the bulk-head bracket, tightening the bolts securely. Reconnect the fluid pipe, taking care to ensure a tight joint, but do not overtighten as this will damage the threads in the casting. The push-rod may then be connected to the pedal by inserting the clevis pin, using a new split-pin if the one removed is damaged in any way. The reservoir must then be filled and the system bled as already described.

5:4 Operating cylinder

The clutch operating (slave) cylinder is located on the clutch housing (**FIG 5:4**), the method of mounting may vary slightly as between different types of car.

To remove the cylinder, access must first be obtained to the area around the gearbox by taking off the gear-lever knob and draught excluder, carpet, and gearbox cover. Detach the hydraulic pipeline (with a blanking plug handy to insert in the union hole as soon as the pipe is removed). Slacken the pinch bolt shown on **FIG 5:8**, and remove the bolt and nut. The slave cylinder may then be withdrawn, the push-rod remaining attached to the clutch release arm.

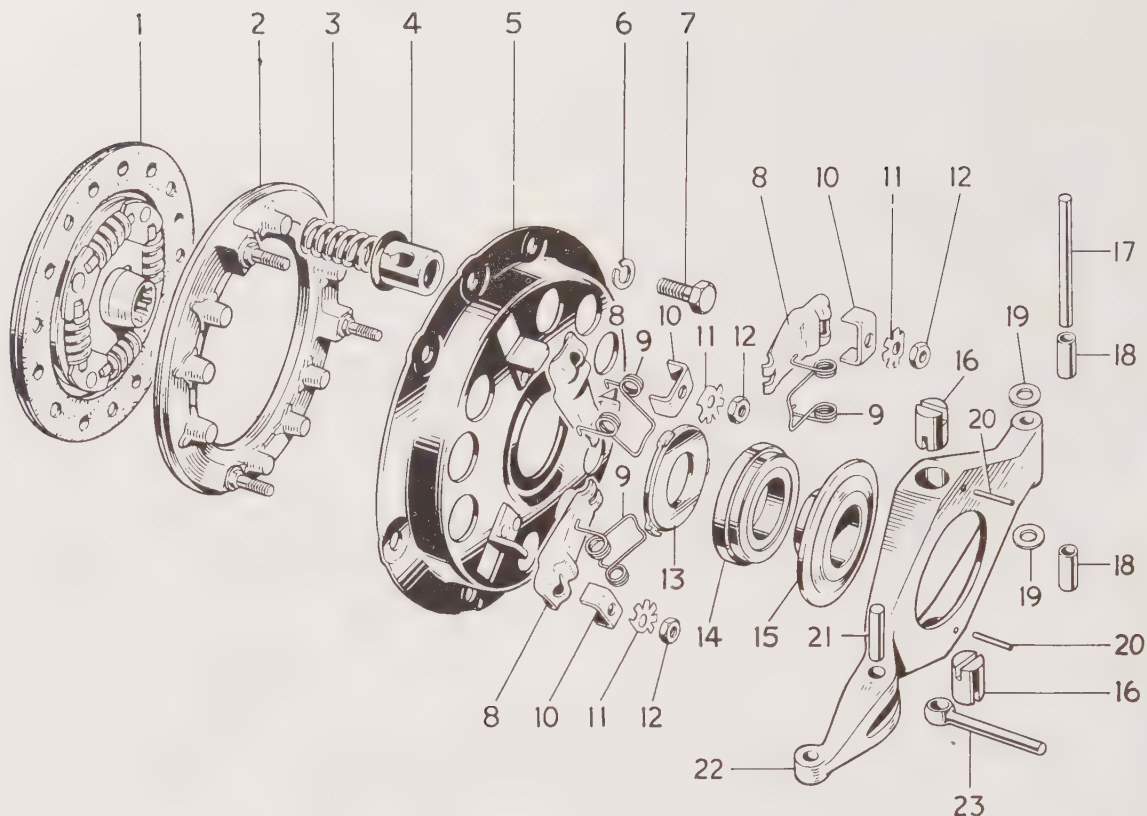


Fig 5:3 Clutch components and operating mechanism, early 'Spitfire', coil-spring type.

Key to Fig 5:3 1 Driven plate. 2 Pressure plate. 3 Thrust spring. 4 Spring cup. 5 Clutch cover. 6 Spring washer. 7 Setscrew. 8 Toggle. 9 Retaining spring. 10 Bridge piece. 11 Lockplate. 12 Adjusting nut. 13 Release lever plate. 14 Release bearing. 15 Bearing carrier. 16 Thrust plugs. 17 Hinge pin. 18 Bush. 19 Spacer washer. 20 Lockpin. 21 Push-rod pin. 22 Operating lever. 23 Push-rod.

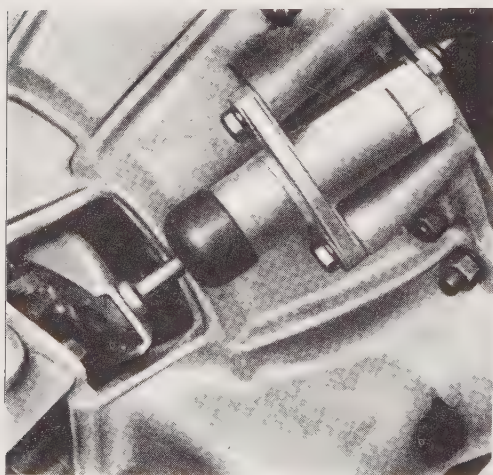


Fig 5:4 Operating (slave) cylinder. Note position of bleed nipple.

With flange mounting (**FIG 5:4**) a similar procedure is followed, the cylinder being finally detached by removing the nuts and attachment bolts from the flange.

With the rubber boot removed from the cylinder end, the parts can be dismantled from the cylinder. Referring to **FIG 5:8**, remove the circlip and tap the cylinder lightly on a block until the seal, spring and piston emerge. The bleed valve at the blank end of the cylinder is unscrewed and removed along with its ball. The piston seal can then be pulled off its spigot on the front end of the piston. Reference to **FIG 5:8** will help to clarify the position of these parts.

All parts must be cleaned, using no liquid but brake fluid. The piston seal should be examined for damage or wear and renewed if necessary. To reassemble the cylinder, first fit the seal on the piston spigot with the lip facing the blank end of the cylinder in the direction of pressure. Dip the piston and seal in hydraulic fluid and carefully insert in the cylinder, taking the same precautions as detailed for the master cylinder. Then replace the bleed valve, with its ball but do not tighten as the system has to be bled.

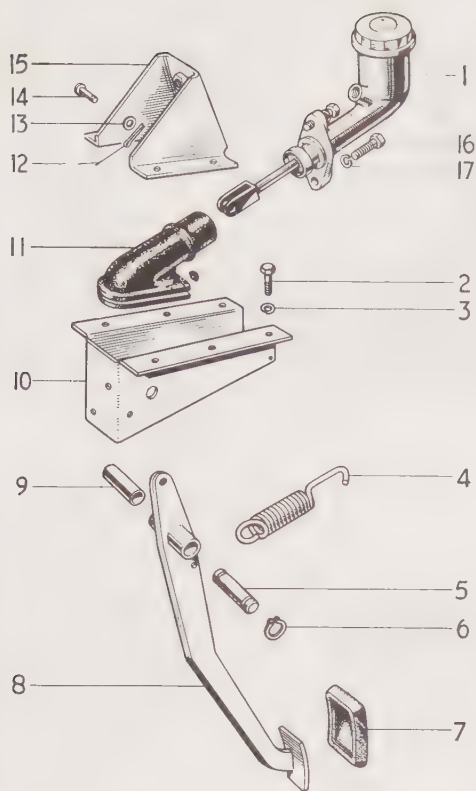


Fig 5:5 Clutch master cylinder and pedal mechanism.

Key to Fig 5:5 1 Master cylinder. 2 Bolt. 3 Washer. 4 Return spring. 5 Pivot pin. 6 Circlip. 7 Pedal rubber. 8 Pedal. 9 Bush. 10 Bracket. 11 Dust excluder. 12 Split-pin. 13 Washer. 14 Clevis pin. 15 Bracket. 16 and 17 Bolt and washer.

Refit the cylinder to the clutch housing, carefully noting that the circlip and boot are correctly positioned at the cylinder end, and at the same time entering the push-rod through the boot centre so that it engages the piston recess. The fluid pipe may then be reconnected, taking care not to overtighten and cause damage to the threads. Check for free movement and then bleed the system as already detailed.

5:5 Clutch dismantling

To obtain access to the clutch and its release bearing, etc., it is necessary to part the housing flange, as described in Chapters 1 and 6. The clutch release mechanism is located in the gearbox part of the housing.

Access to the plate is obtained after removing the pressure unit from the flywheel, following the procedure as in the chapters mentioned above. The driven plate should be carefully examined to ensure that it is not unduly worn and that the linings are secure and do not show suspicious signs of discolouration. If defective, the complete plate must be replaced. In normal use the linings take on a polish, giving very smooth engagement with adequate transmitting capacity, if the spring pressure is sufficient.

This polish is easy to see, but does not affect the colour of the linings, which together with the natural grain of the material can be seen quite clearly through the glaze. Darkening of the surface denotes that small quantities of oil have been present, but have been burnt off as a result of heat generated during starting. A momentary defect of this kind has little effect on performance, and in fact is more likely to make the clutch fierce when engaging than to cause slip.

Larger quantities of oil not only give a much darker appearance to the linings but will only burn off in part and leave a definite deposit on the surface. This then becomes glazed, but unlike the 'natural' polish gives a coating to the face which will spoil the frictional grip. To some extent also it causes the plate to stick on engagement, so that the clutch will not free properly when the pedal is depressed but will at the same time slip when driving; this state of affairs can cause a lot of confusion.

The more oil present the worse the effects, so that any discolouration of the linings must be suspect, and other evidence looked for of oil coming from somewhere in quantity.

5:6 Pressure unit

The pressure unit should be left alone, apart from examining the face of the pressure plate for signs of scoring, overheating or distortion. If weakening of the clutch springs or uneven withdrawal (due to inaccurate setting of the levers) is suspect, the unit should be examined by an agent equipped with the necessary gauges, and a replacement fitted if advised. The foregoing applies regardless of whether the pressure unit assembly is of coil or diaphragm spring type, but must be particularly emphasised in respect to the latter.

5:7 Release bearing

As the release bearing lever and components are normally supplied as a complete assembly, it is advisable to replace as a unit in case of trouble. However, the assembly may be dismantled after removing the gearbox. **FIG 5:9** shows the release lever and bearing fitted to the 'Spitfire' model. The lever is detached by driving out the pivot pin, using a hammer and drift. Support the lever and bearing on a block and drive out the pins which secure the bearing thrust plugs. The plugs can then be removed from the carrier with an extractor.

To reassemble, the release bearing is first fitted to the carrier, and the latter secured to the release lever by insertion of the thrust plugs. The latter are then secured by driving in the retaining pins, with the member supported as when dismantling.

When replacing the assembly, first smear the spigot on which the bearing carrier slides, with a light coating of zinc-base grease, and then slide on the carrier and bearing. The push-rod must next be entered into the clutch operating cylinder (if the latter has been left in position) and at the same time the adjusting rod is passed through its hole in the housing. The hinge pin is then replaced.

On six-cylinder engines, a completely different type of release lever is fitted, which pivots on a ball-ended stud

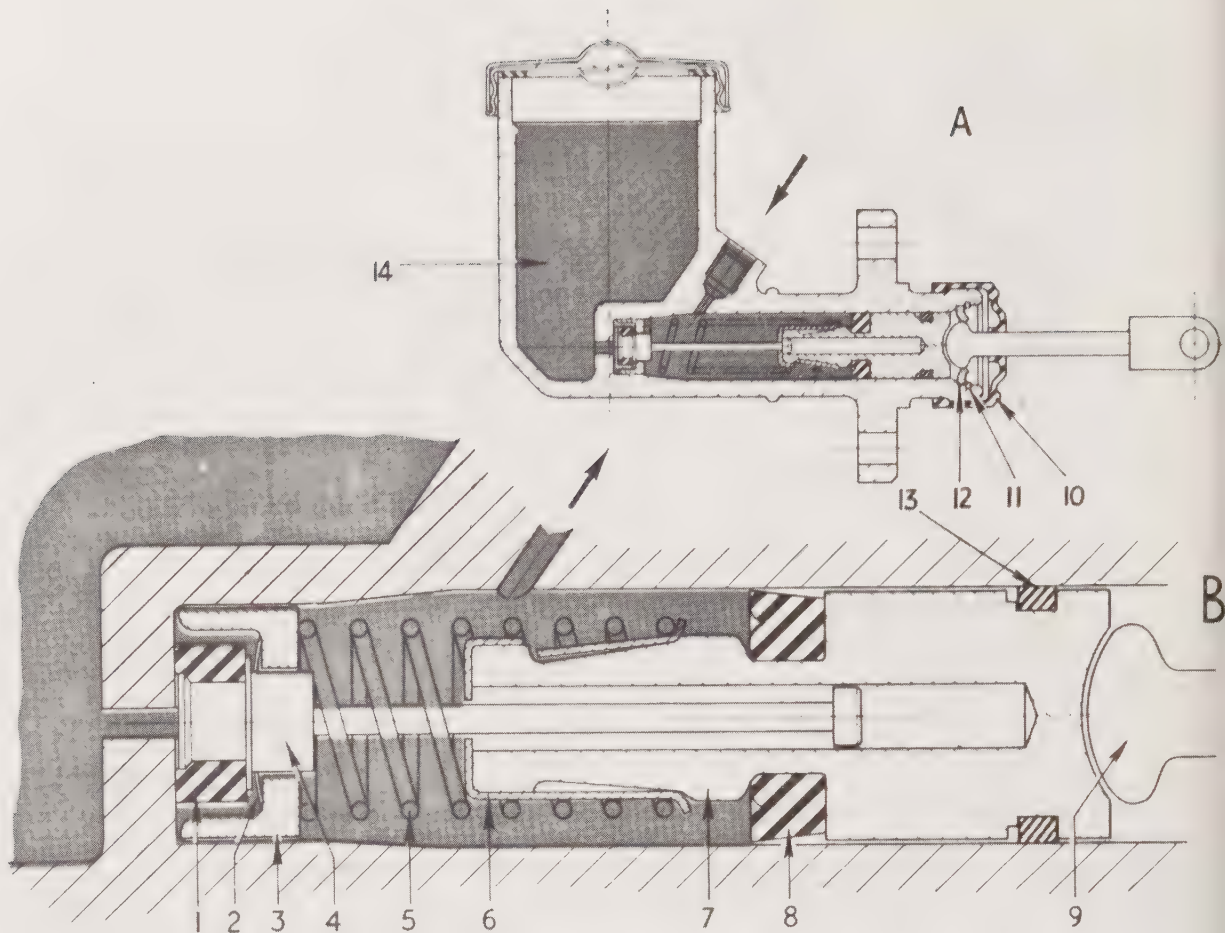


Fig 5:6 Section of master cylinder.

Key to Fig 5:6 1 End seal. 2 Bent washer. 3 Spacer. 4 Valve shank. 5 Main spring. 6 Retainer. 7 Plunger. 8 Seal. 9 Push-rod. 10 Rubber boot. 11 Circlip. 12 Washer. 13 Dust seal. 14 Reservoir.

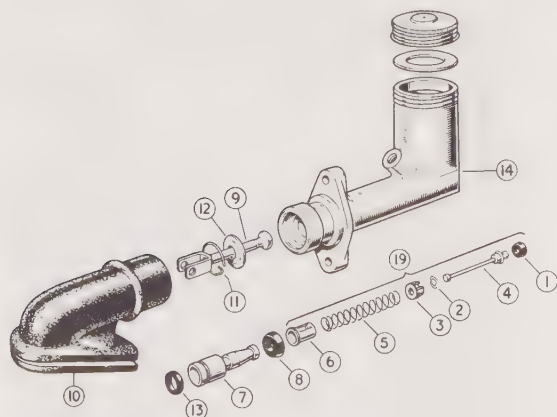


Fig 5:7 Components of master cylinder. (For part numbers refer to Fig 5:6.)

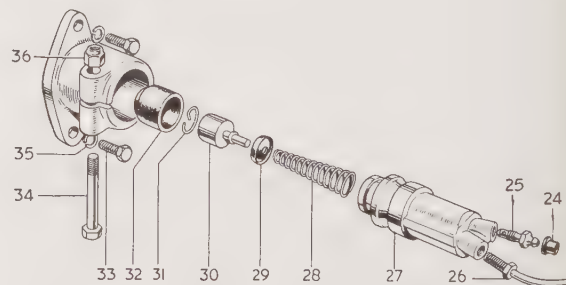


Fig 5:8 Components of operating (slave) cylinder with pinch-bolt clamp.

Key to Fig 5:8 24 Nipple cover. 25 Bleed nipple. 26 Pipe union. 27 Cylinder. 28 Spring. 29 Seal. 30 Piston. 31 Circlip. 32 Rubber boots. 33 Bolt to housing. 34 Pinch bolt. 35 Washer. 36 Pinch bolt nut.

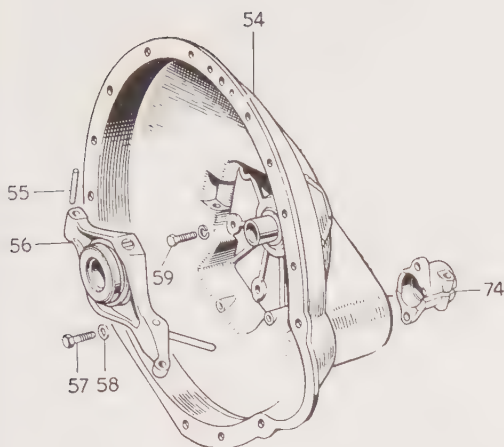


Fig 5:9 Clutch withdrawal lever and parts, 'Spitfire' cars.

Key to Fig 5:9 54 Housing. 55 Pivot pin. 56 Withdrawal lever. 57, 58 and 59 Bolts and washers. 74 Clutch cylinder attachment.

carried on the gearbox housing as shown on **FIG 5:10**. The action of the lever will be evident from the illustration. It has two fixed trunnions which engage the bearing carrier, and at its fulcrum on the stud there is a spring retaining clip riveted to the lever. By springing this clip outwards, the lever can be slid up and clear of the carrier, and all parts readily removed.

5:8 Fault diagnosis

(a) Drag or spin

- 1 Oil or grease on driven plate linings
- 2 Bent engine backplate
- 3 Misalignment between engine and gearbox first motion shaft
- 4 Leaking master cylinder, slave cylinder or pipeline
- 5 Driven plate hub binding on first motion shaft splines
- 6 Binding of first motion shaft spigot bearing
- 7 Distorted clutch plate
- 8 Warped or damaged pressure plate or clutch cover
- 9 Broken driven plate linings
- 10 Dirt or foreign matter in clutch
- 11 Air in clutch hydraulic system

(b) Fierceness or snatch

- 1 Check 1, 2, 3 and 4 in (a)
- 2 Worn clutch linings

(c) Slip

- 1 Check 1, 2 and 3 in (a)
- 2 Check 2 in (b)

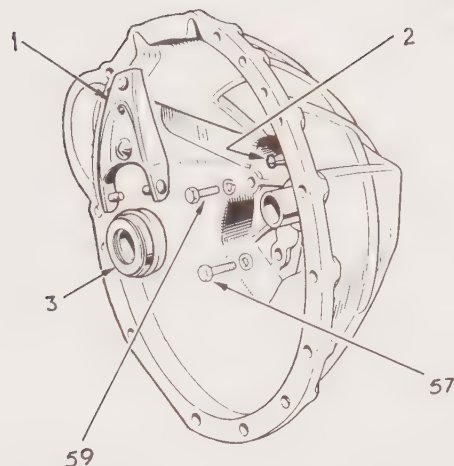


Fig 5:10 Clutch withdrawal lever and parts, 6-cylinder cars.

Key to Fig 5:10 1 Withdrawal lever. 2 Stud-type pivot. 3 Thrust bearing. 57/59 Bolts.

- 3 Weak pressure springs
- 4 Seized piston in clutch slave cylinder

(d) Judder

- 1 Check 1, 2 and 3 in (a)
- 2 Pressure plate not parallel with flywheel face
- 3 Contact area of driven plate linings not evenly distributed
- 4 Bent first-motion shaft
- 5 Buckled driven plate
- 6 Faulty engine or gearbox mountings
- 7 Worn suspension bushes
- 8 Loose propeller shaft bolts

(e) Rattle

- 1 Check 3 in (c)
- 2 Broken springs in driven plate
- 3 Worn release mechanism
- 4 Excessive backlash in transmission
- 5 Wear in transmission bearings

(f) Tick or knock

- 1 Worn first-motion shaft spigot or bearing
- 2 Badly worn splines in driven plate hub
- 3 Release plate out of line
- 4 Faulty pinion drive on starter motor
- 5 Loose flywheel

(g) Driven plate fracture

- 1 Check 2 and 3 in (a)
- 2 Drag and distortion due to hanging gearbox in plate hub

CHAPTER 6

THE TRANSMISSION

- 6:1 Gearbox removal**
- 6:2 Selector mechanism**
- 6:3 Overdrive unit**
- 6:4 Electrical circuit**

- 6:5 Propeller shaft**
- 6:6 Universal joints**
- 6:7 Fault diagnosis**

The gearbox is of the normal constant-mesh four-speed type, having synchromesh on the upper three forward ratios on the 'Spitfire' and 'Vitesse' 1.6 litre, and on all four on 2-litre cars. No adaptation is feasible as between internal components for conversion purposes, neither are the boxes interchangeable. **FIG 6:1** shows the general construction in section, the various components being detailed in **FIG 6:2**.

Trouble inside the gearbox is unlikely so long as the car is handled intelligently, but in any case, dismantling is an involved operation requiring the use of much special equipment. In the event of trouble therefore, specialist advice should be sought.

Control in all cases is by a short manually-operated gear lever mounted remotely. The method of gear selection is quite conventional, all wheels in constant-mesh being of the single helical type to encourage quiet operation. Normal maintenance consists of periodic checking of the gearbox oil level. Drain plugs are not used on later boxes; in case of doubt as to draining requirements, the latest servicing instructions current for the particular type should be adhered to.

6:1 Gearbox removal

For access to the clutch as described in Chapter 5, or for gearbox overhaul, the latter can be removed leaving the engine in the frame. The car should first be raised on a ramp or axle stands, so as to give as much room underneath as possible. The battery is next disconnected and the front seats and carpets removed. On 'Spitfire' models, there is a support casting between the dashboard and floor just ahead of the gear lever, and this must be taken

off by removing its bolts, after detaching the tachometer drive cable from the meter. Take off the gear lever knob and rubber cover, followed by the cover over the gearbox which is secured by screws and fasteners (refer back to **FIG 1:5**). The brake operating cylinder must next be detached from the housing, but its fluid pipe need not be disconnected; tie the cylinder out of the way so that no strain is imposed on the flexible pipe. The bolts and nuts on the propeller shaft flange at the rear of the gearbox must next be unscrewed and the shaft detached. The exhaust pipe is then uncoupled from the manifold and from its support on the clutch housing, the speedometer drive cable uncoupled from the gearbox extension, and the starter motor taken off.

The nuts at the attachment flange of the remote control housing to the top of the gearbox are now unscrewed, the housing complete with gear lever removed, and a cardboard cover put over the gearbox opening to prevent entry of dirt.

Remove the nuts from the gearbox chassis mounting at the rear of the output shaft extension, and jack up underneath the engine until the extension is clear of the mounting bracket, enabling the mountings to be withdrawn. Make sure that the engine is properly supported while this is being done.

The gearbox must now be supported so that when the clutch housing bolts are slackened (refer back to **FIG 1:8**) there is no strain on the clutch shaft. Unscrew the bolts (and nuts where fitted) and remove them completely when sure that the box support is adequate; pull the box rearwards, taking care that it remains level so that the clutch shaft pulls straight out of the flywheel and

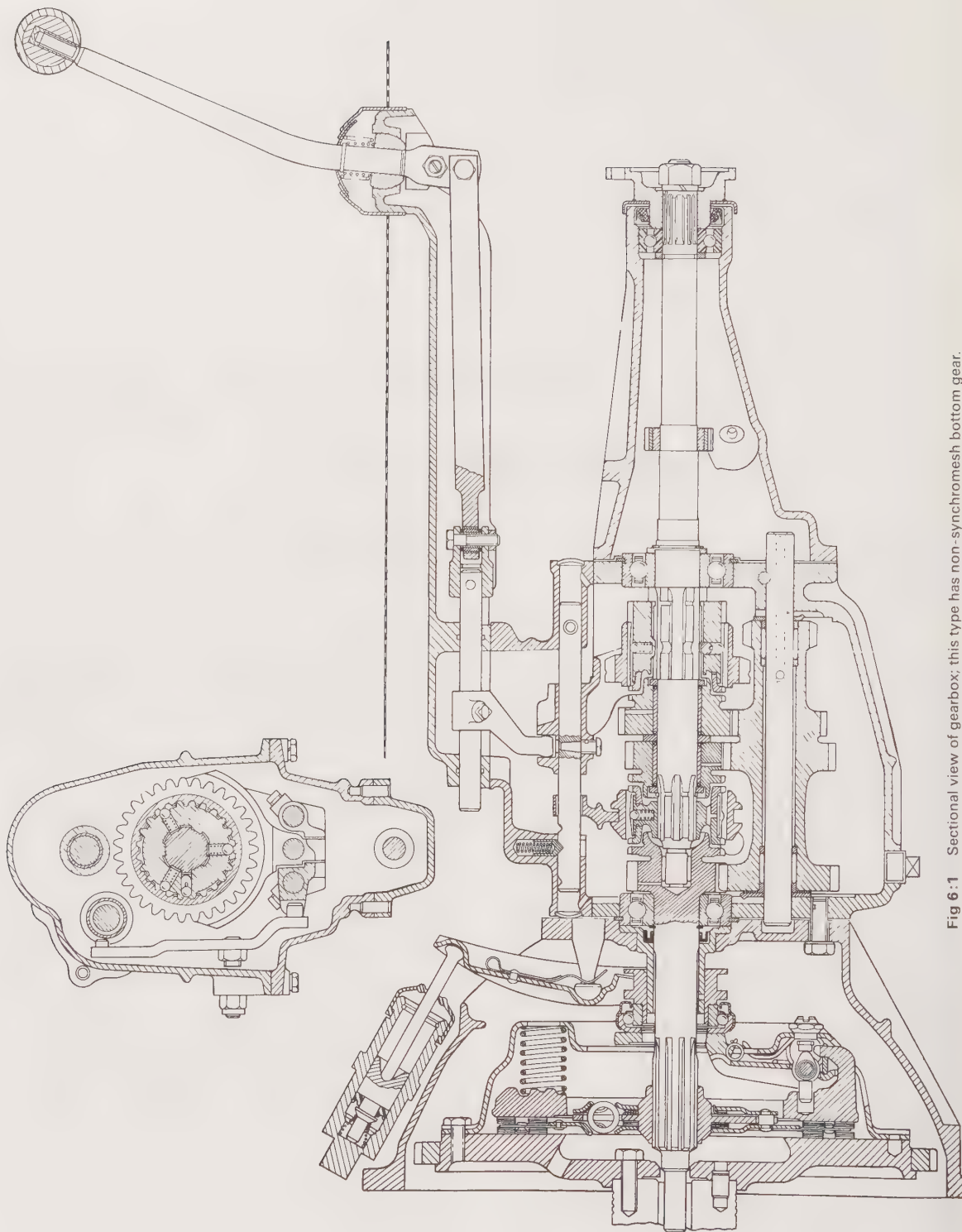


Fig 6:1 Sectional view of gearbox; this type has non-synchromesh bottom gear.

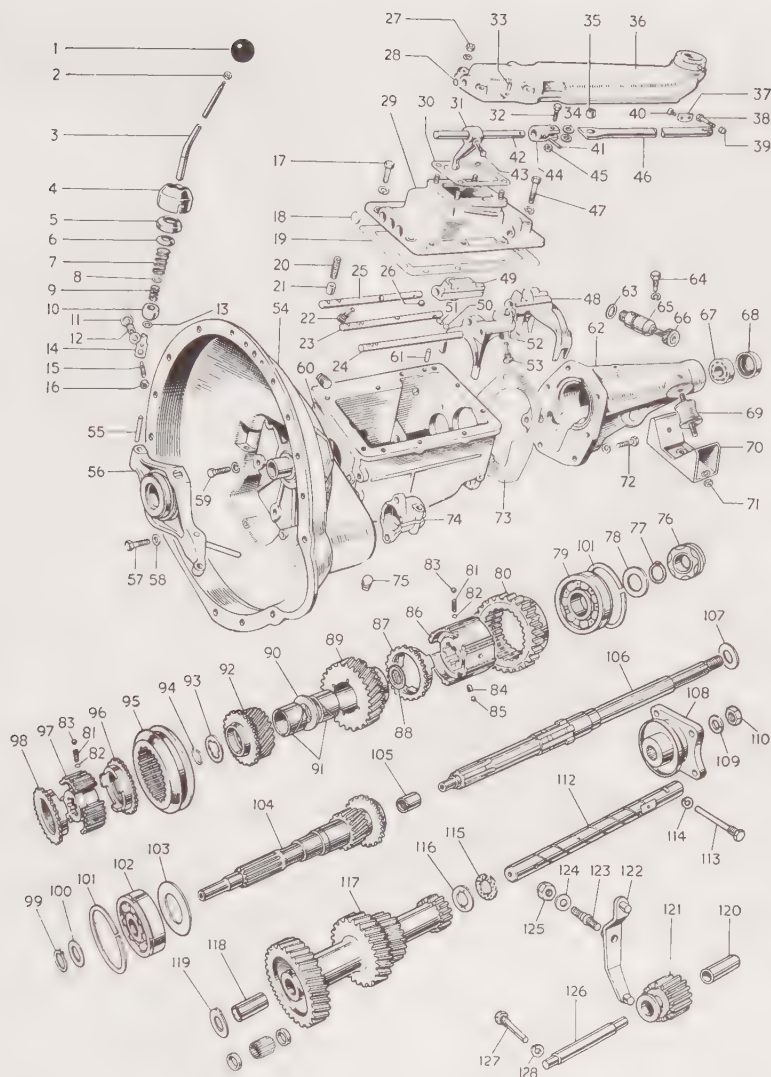


Fig 6:2 Components of gearbox. Type fitted to 1998 cc cars has synchromesh bottom gear, but construction is otherwise similar.

Key to Fig 6:2 1 Knob. 2 Locknut. 3 Gear change lever. 4 Cover. 5 Shield. 6 Plate. 7 Spring. 8 Circlip. 9 Spring. 10 Nylon sphere. 11 Stepped nylon washer. 12 Bush. 13 Washer. 14 Lever end. 15 Reverse stop pin. 16 Locknut. 17 Bolt. 18 Welch plug. 19 Gasket. 20 Spring. 21 Plunger. 22 Taper locking pin. 23 1st/2nd selector shaft. 24 3rd/top selector shaft. 25 Reverse selector shaft. 26 Interlock ball. 27 Nut. 28 Rubber 'O' ring. 29 Top cover. 30 Gasket. 31 Selector ball-end. 32 Bolt. 33 Dowel. 34 Washer. 35 Bonded rubber bush. 36 Gear change extension. 37 Reverse stop. 38 Bolt. 39 Nyloc nut. 40 Screw. 41 Mills pin. 42 Remote control shaft (front). 43 Taper locking pin. 44 Fork. 45 Nut. 46 Remote control shaft (rear). 47 Bolt. 48 1st/2nd selector fork. 49 Reverse selector. 50 Interlock ball. 51 Interlock plunger. 52 Top/3rd selector fork. 53 Taper locking pin. 54 Clutch housing. 55 Pin. 56 Clutch release mechanism. 57 Wedglock bolt. 58 Plain washer. 59 Bolt. 60 Gasket. 61 Dowel. 62 Rear extension. 63 Rubber 'O' ring. 64 Peg bolt. 65 Speedo drive gear housing. 66 Speedo drive gear. 67 Extension ball race. 68 Oil seal. 69 Gearbox mounting rubber. 70 Mounting bracket. 71 Nut. 72 Bolt. 73 Gasket. 74 Clutch slave cylinder bracket. 75 Sump plug. 76 Speedo driving gear. 77 Circlip. 78 Distance washer. 79 Ball race. 80 1st speed gear. 81 Spring. 82 Shim. 83 Synchromesh ball. 84 Plunger. 85 Ball. 86 2nd speed synchro hub. 87 2nd speed synchro cup. 88 Thrust washer. 89 2nd speed mainshaft gear. 90 Thrust washer. 91 Bushes. 92 3rd speed mainshaft gear. 93 Thrust washer. 94 Circlip. 95 3rd/top synchro sleeve. 96 3rd speed synchro cup. 97 3rd/top inner synchro hub. 98 Top synchro cup. 99 Circlip. 100 Distance washer. 101 Circlip. 102 Ball race. 103 Oil deflector. 104 Input shaft. 105 Torrington needle roller bearing. 106 Mainshaft. 107 Distance washer. 108 Driving flange. 109 Spring washer. 110 Nut. 112 Countershaft. 113 Peg bolt. 114 Spring washer. 115 Rear fixed thrust washer. 116 Rear rotating thrust washer. 117 Countershaft gear cluster. 118 Countershaft bush. 119 Front fixed thrust washer ('Vitesse' has needle rollers and retaining rings). 120 Reverse gear bush. 121 Reverse gear. 122 Reverse gear actuator. 123 Actuator pivot. 124 Plain washer. 125 Nyloc nut. 126 Reverse gear shaft. 127 Reverse shaft retaining bolt. 128 Spring washer.

clutch-plate centre. When refitting the box, the procedure is largely a reversal of the above. If the clutch has received attention, it is important that the plate is properly aligned, so that the input shaft can enter freely. If this is ensured, and the box is kept properly lined-up and supported when offering up to the engine, no trouble should be experienced in uniting the components at the flange.

The splines on the input shaft to the clutch-plate should be very lightly smeared with white (zinc-base) grease before assembly. A few of the flange bolts are then inserted and lightly tightened. After fitting all the bolts and nuts, and to ensure evenness, it is a good idea to tighten them diametrically across the housing as far as possible, and to pull each up a little at a time until all are tight. If there is difficulty in entering the clutch shaft because of its spline positioning, engage one of the gears; this will allow the input shaft to be rotated as required by turning the propeller shaft flange.

The propeller shaft must be refitted with the flanges in the same positions as when removed, and the nuts or bolts firmly tightened.

6:2 Selector mechanism

If it is desired to inspect the gearbox interior, the top cover can be removed, after taking off the remote control housing as already detailed. The selector mechanism is contained in the cover as shown on **FIG 6:3**. Access to the selector lock plungers and springs is obtained by driving out the three welch plugs at the end of the cover, using a 0.125 in (3.17 mm) punch from inside the cover. Take care that the selector shafts are not damaged when doing this. Unscrew the threaded and tapered pins from the selector forks, and push out the three selector shafts in turn, starting with the right-hand one looking forward from

the gear-lever. As the shafts are withdrawn, take care to collect the two interlock balls and cross-plunger, three shaft plungers and three springs. When reassembling with new parts if required, take great care that these components are replaced in their correct positions, as detailed later.

In the unlikely event of trouble occurring with the gears or synchromesh mechanism, the box should be returned to an agent who will have the necessary overhaul facilities. Replacement gearboxes are available on an exchange basis, and this is the obvious course, particularly if time is short.

To reassemble the selector mechanism, the selector shaft for third and top gears is inserted first, this being the left-hand one looking forward from the gear lever. Slide the shaft through the front end of the cover, pressing down the plunger so that the shaft can pass it and through the selector fork. Then push the shaft further, until its middle indent or notch registers with the plunger; this is the neutral position for the shaft. The same procedure is then followed with the right-hand (reverse) gear selector shaft, leaving this also in the neutral position. Finally the centre shaft controlling first and second gears is fitted, noting that, before it is positioned the interlock plunger must be fitted. Before pushing the shaft to its neutral point, the two interlock balls which are positioned at each end of the interlock plunger, are inserted into the transverse drilling connecting the shaft bores. Reference to **FIG 6:3** will make all this quite clear. When the shaft has finally been pushed to its neutral position (middle indent) the interlock balls and plunger will be retained in their correct places by the outer shafts, and whichever shaft is moved the other two will be locked in neutral. This action may be checked, and the cover replaced after ensuring that the

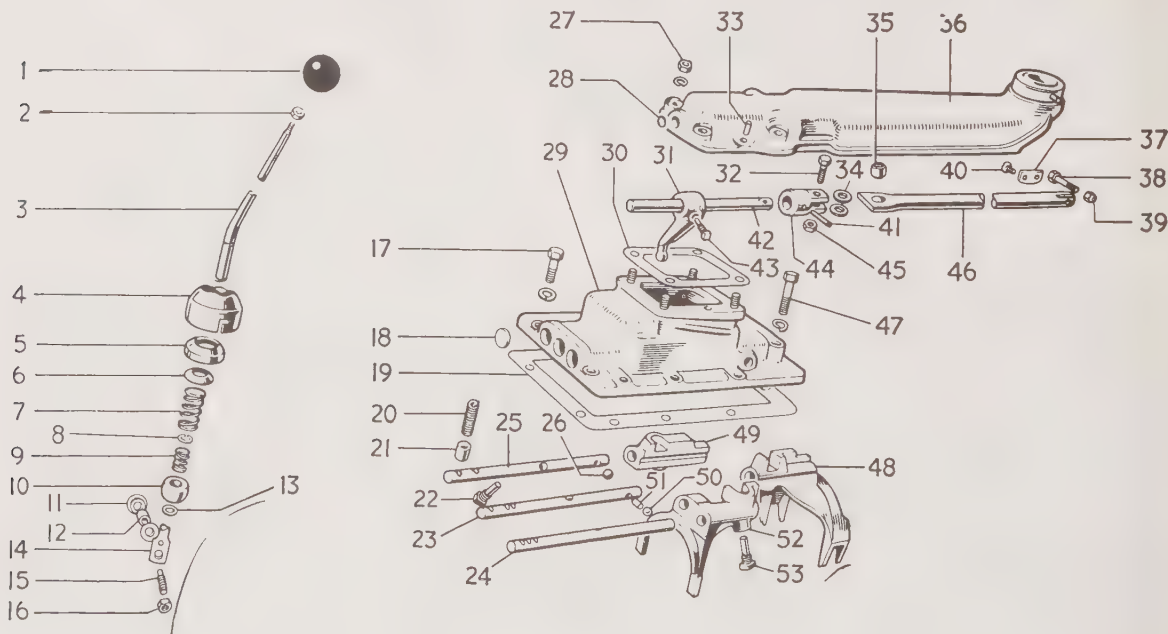


Fig 6:3 Gearbox top cover and selector mechanism. (For part numbers refer to **Fig 6:2**.)

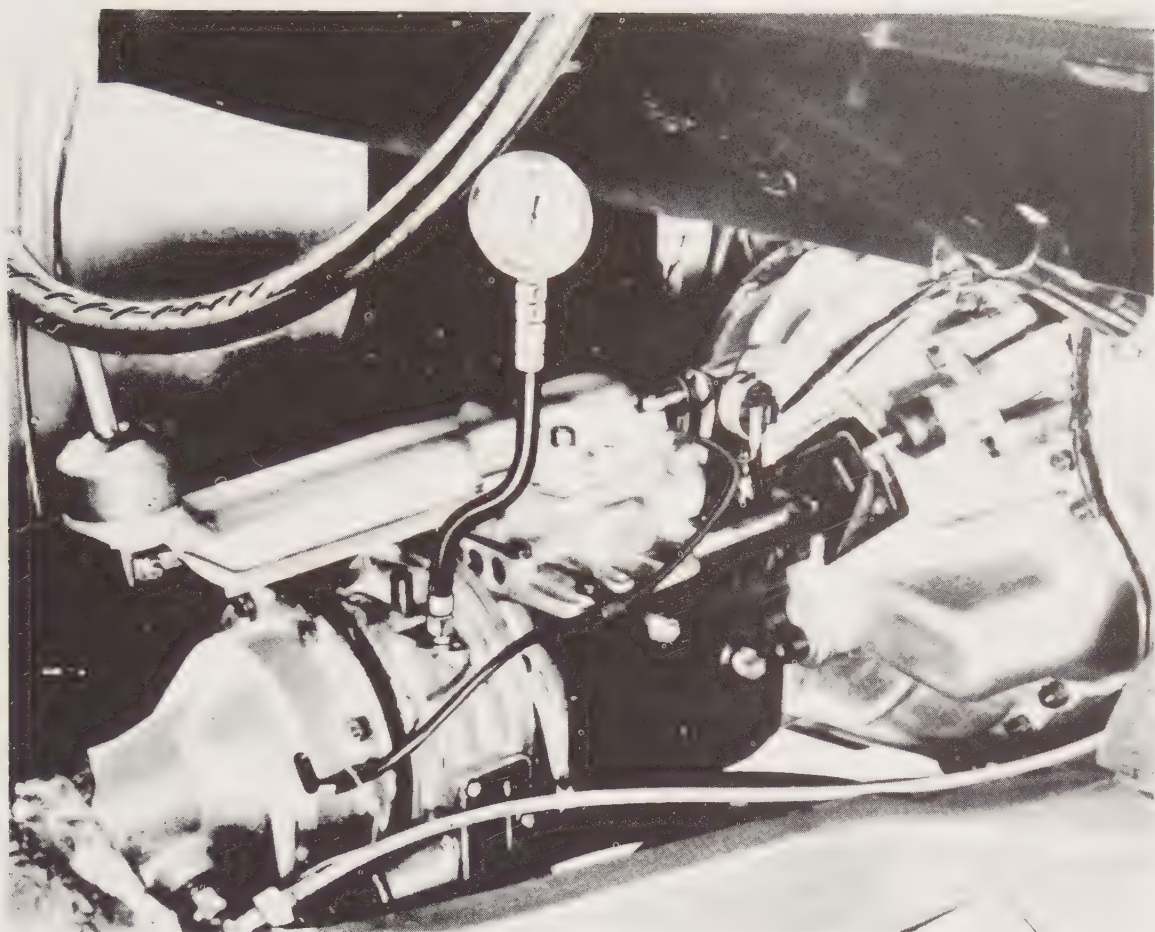


Fig 6:4 Overdrive unit at rear of gearbox. The gauge shown is being used for oil-pressure test (see text)

gears are correctly positioned to receive the selector forks.

6:3 Overdrive unit

An overdrive unit of Laycock-de Normanville type is available, this providing an effortless cruising ratio with the car speed about 25 per cent higher than when driven in normal top gear for equivalent engine rev/min. For many kinds of driving, particularly motorway cruising, the device has many advantages in respect of reducing fuel consumption, engine wear and driving fatigue.

The overdrive comprises an auxiliary gearbox mounted on the rear face of the normal box in place of the output shaft extension housing, as shown on FIG 6:4. It is operated electrically through a solenoid by means of a switch within easy reach of the driver. An inhibitor switch in the electrical circuit prevents engagement of the overdrive in any ratio other than third and top.

The principle of operation is shown on FIG 6:5. It will be seen that there is an epicyclic gear train comprising a

central sun wheel meshing with three planetary pinions which mesh with an internally toothed annulus.

Referring to the upper illustration on FIG 6:5, this shows the device out of action, when it merely functions as a transmission shaft and is locked in position. The cone clutch A fitted to the splined extension of the sun wheel G, is loaded by means of clutch springs L operating through a thrust bearing assembly KM. The direction of loading engages the inner cone face of the clutch with the external cone face of annulus E. It will thus be seen that the gear train is locked, and torque in either direction of rotation will be transmitted just as if a solid shaft was used.

The operative position is shown in the lower illustration. Hydraulic pistons I operating against a bridgepiece J move to the left, withdrawing the cone clutch A against the spring pressure. This disengages the clutch from the annulus E, but on further movement the outer face of the cone engages a brake ring B on the overdrive casing. The sun gear wheel G is thus held stationary, through its

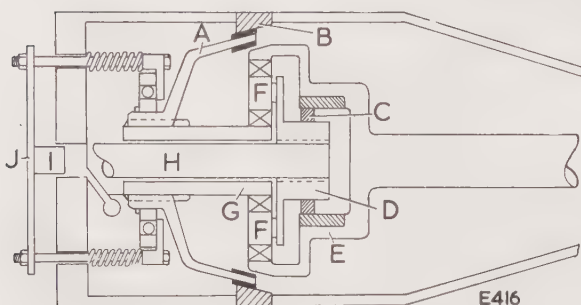
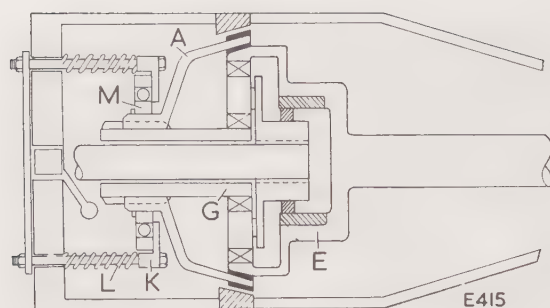


Fig 6:5 Principle of operation of overdrive. *Top:* disengaged. *Bottom:* engaged. For lettering refer to text.

splined extension into the boss of clutch A. The planet carrier D rotating with the input shaft will now carry the planetary pinions around with it. The latter are engaging a fixed sun gear at G, and will therefore drive the annulus E at a faster speed than that of the input shaft. As the annulus is attached to the output shaft, the latter is also speeded up in relation to the input shaft. A freewheeling clutch at D allows this over-run of the output shaft relative to the input shaft, but at the same time ensures that there is no interruption of the drive during the change of ratio.

The hydraulic pressure for operating the overdrive clutch is generated by a plunger pump driven from the input shaft of the overdrive unit. The pump intake has a wire-mesh filter, and delivery is through an operating valve. Hydraulic pressure is controlled by a relief valve.

The action of the valve can be seen by reference to **FIG 6:6**. In the direct drive position the ball valve G is firmly on its seat in the casing and the oil entering at B is isolated from the outlet F which leads to the operating cylinders of the cone clutch. When the switch is in the overdrive position, the cam D is rotated by a solenoid. This lifts the valve G from its seat and seals it against the top of the housing, so that there is now a free passage between the inlet B and the outlet F. On returning the switch to direct drive, the oil from the operating cylinders is exhausted from F, down the hollow valve stem and through a restrictor E.

The overdrive housing and the normal gearbox are interconnected, and share the same lubricant, the correct level being as determined by the gearbox filler plug. The

gauze intake filter can be inspected and cleaned by removing the cover plate shown on **FIG 6:7** which is held by four screws. To gain access to the operating valve and other components, it is necessary to remove the cover over the gearbox as described earlier. The valve plug is on top of the overdrive unit and before removing it, the hydraulic pressure must be released by operating the control switch a few times. The valve spring, plunger and valve can be withdrawn by the use of a small magnet. To lift out the valve-stem great care is necessary, as damage to its seat must be avoided. Removal is effected by passing a length of stiff wire down the bore of the stem, and persuading the stem to come up the bore. When the stem has been withdrawn, check that the central passage, and in particular the small hole at the bottom, is clean.

If it is considered that the ball is not seating properly, place the ball on a wooden block, invert the valve stem, place it with its seating over the ball, and give the stem end a sharp but fairly gentle tap. Similarly, after cleaning the upper valve seat in the casing, fit the ball on to this, and tap the ball sharply with a copper drift. Do not use much force, as this will close up the mouth of the seat and the ball will not locate properly.

The valve operating cam is secured to a short shaft having a solenoid-operated lever attached to its other end as shown on **FIG 6:8**. The mechanism can be adjusted by first removing the cover plate which is secured by three screws. The operating lever must be moved until it is possible to insert a $\frac{3}{16}$ in (4.762 mm) rod through the hole in the lever, in such a way that it lines up with a corresponding hole in the casing as shown. With the lever thus held, energise the solenoid and then screw the adjusting nut until it just contacts the lever. The aligning rod is then removed and the solenoid switched off. Check the action by switching on and off a few times, noting that the aligning holes correspond properly when the solenoid is energised.

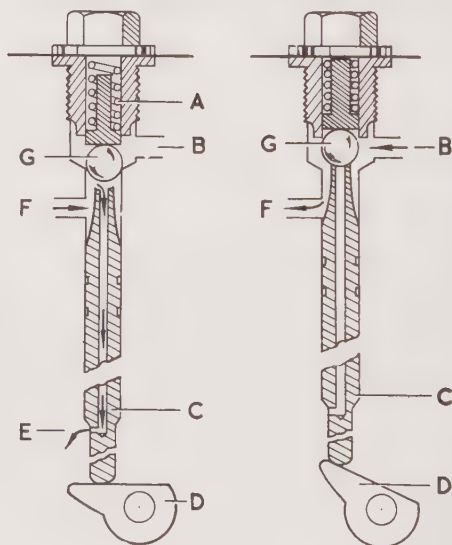


Fig 6:6 Operating valve of overdrive, lettering refers to text description.

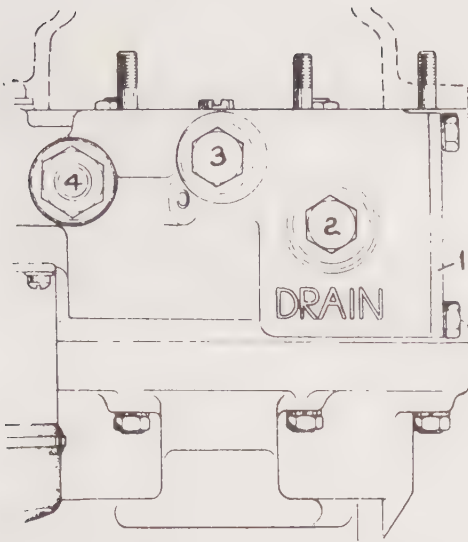


Fig 6:7 Under view of overdrive casing, showing access plugs, etc.

Key to Fig 6:7 1 Filter cover plate. 2 Drain plug. 3 Non-return valve plug. 4 Relief valve plug.

The current consumption can be checked with an ammeter, and should be about 2 amp. If the reading is greatly in excess, say 20 amp, this indicates that the solenoid plunger is not moving sufficiently far to switch from the operating coil to the holding-on coil. Adjustment of the operating lever is then required. It is important to note that a continuous high-current reading must not be allowed, as it will eventually cause failure of the solenoid windings.

To adjust in these circumstances, de-energise the solenoid, realign the holes and insert the rod as before. Referring to **FIG 6:9** hold the solenoid plunger against the

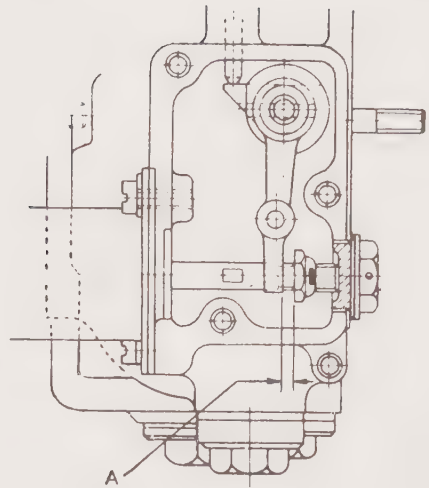


Fig 6:9 Adjustment of solenoid as explained in text. Dimension A=0.150–0.155 in (3.81–3.937 mm).

blanking plug and check that the dimension shown at A is 0.150 to 0.155 in (3.81 to 3.937 mm). To obtain this dimension, the thickness of washer between the plug and the casing may be varied.

Alternatively, there may be an adjustable stop fitted. In this case with the holes aligned and the rod in position, hold the plunger against the adjustable stop, and then adjust the stop until there is a gap of the same dimensions as just stated, between the lever fork and the nut. With this gap correct, tighten the locknut against the bracket of the solenoid, until one of the slots in the nut aligns with the hole in the stop, and fit a locking wire.

The hydraulic pressure is checked after removing the operating valve plug, by fitting a pressure gauge (part No. L.188) to the opening, as shown on **FIG 6:4**. The pressure should first be released by operating the switch several times with top gear engaged. The rear wheels must then be jacked up very securely, and the front wheels chocked to prevent accident. Start the engine and run it in top gear to an indicated speed of about 20 mile/hr. The pressure gauge reading should be 510 to 530 lb/sq in. Low pressure may indicate that the filter, relief valve, or pump non-return valve, require cleaning. Access to the relief valve is via a plug at the bottom of the front casing as shown on **FIG 6:7**. After removing this plug and the spring, the valve body can be withdrawn by using a hook-shaped piece of stiff wire to pull it out. The plunger may then be extracted from the body, and all components cleaned.

The pump action can be checked by running the engine in gear (as for the pressure check), with the operating valve plug removed. Oil should be seen in the process of being pumped into the valve chamber. If this is not so, remove the non-return valve body by unscrewing its plug, which is positioned as shown on **FIG 6:7**. After

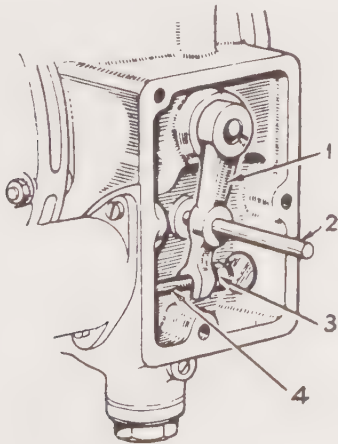


Fig 6:8 Solenoid operation of valve with cover plate removed.

Key to Fig 6:8 1 Operating lever. 2 Setting rod. 3 Adjusting nut. 4 Solenoid plunger.

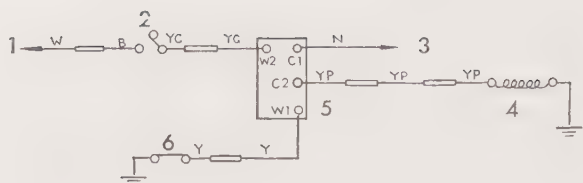


Fig 6:10 Wiring diagram for overdrive unit.

Key to Fig 6:10 1 Connection to SW terminal (coil). 2 Overdrive switch. 3 Connection to No. 1 on ignition switch 4 Solenoid. 5 Relay. 6 Gearbox isolator switch.

thoroughly cleaning the parts, the ball should be seated by tapping it sharply on to the seat in the manner described for the operating valve.

Occasionally the overdrive cone clutch has been known to stick in engagement, but this is most likely to occur when new, and before the parts have become bedded-in. It is usually possible to free the clutch by giving the brake ring (**FIG 6:5**) a few hard blows with a hide mallet from underneath the car.

6:4 Electrical circuit

If trouble is experienced with the overdrive control in any way, it is essential first to check the electrical circuit; failure to operate is often caused by corrosion, loose connections, etc. It is necessary that earthing connections are really well-made, as the current taken by the solenoid in engaging the overdrive ratio is quite heavy. A wiring diagram is shown on **FIG 6:10**. If the operation is still defective after all connections have been checked, the following procedure should be carried out.

Switch on the ignition, engage top gear, and set the operating switch to the overdrive position. Take a voltage reading at terminals C1 and W2 (**FIG 6:10**) on the relay unit. There should be full battery voltage. Next short-circuit the terminals C1 and C2, thus allowing current to flow directly to the solenoid. If the latter operates, the relay unit, switch, and isolating switch on the gearbox, must all be suspect.

Remove the short-circuiting link from terminals C1 and C2, and earth terminal W1. If the solenoid now operates, suspect the gearbox isolating switch. If the relay unit does not operate, suspect the relay unit and replace it. Finally, earth the yellow/green cable on the switch. If this operates

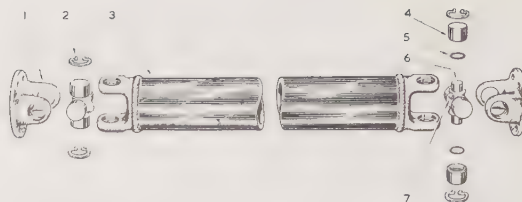


Fig 6:11 Propeller shaft as fitted to earlier cars, non-telescopic type.

Key to Fig 6:11 1 Flanged yoke. 2 Circlip. 3 Propeller shaft tube. 4 Needle roller bearing. 5 Sealing ring. 6 Spider. 7 Lubricating point.

the solenoid, the switch is evidently faulty, and must be replaced. If defective operation cannot be remedied by the attention and adjustments already described, it is advisable to remove the complete overdrive unit and fit a service replacement. There are eight nuts securing the overdrive to the gearbox adaptor, and after removing these and disconnecting the speedometer drive and electrical wiring, the unit can be withdrawn.

6:5 Propeller shaft

The propeller shaft is of conventional type with Hooke-type universal joints at each end. As there is relatively little universal joint action because of the chassis-mounted final drive unit, earlier cars do not incorporate a sliding joint in the shaft, which is shown on **FIG 6:11**. Later cars have shafts with a sliding splined portion (**FIG 6:12**). Other shafts used are the linear roller bearing type (**FIG 6:13**) and the strap drive, illustrated on **FIGS 6:14** and **6:15**.

The shaft is readily removed for inspection and overhaul. Bearing wear may be judged to some extent by feel when in position, as circumferential movement of the flanges relative to the shaft should be negligible; the same applies to a push or pull movement on the flanges.

To take off the shaft, the car should be first raised to give adequate clearance underneath, and the carpets and gearbox cover removed as described earlier. Mark the front and rear flanges with paint, to ensure that the shaft is fitted in the same relationship as before; take out the bolts and nuts from the flanges and detach the shaft complete. In some cases, a slight levering forward of the power unit may be necessary to free the shaft. If roller-bearing splines are incorporated, the sliding end of the shaft may be dis-

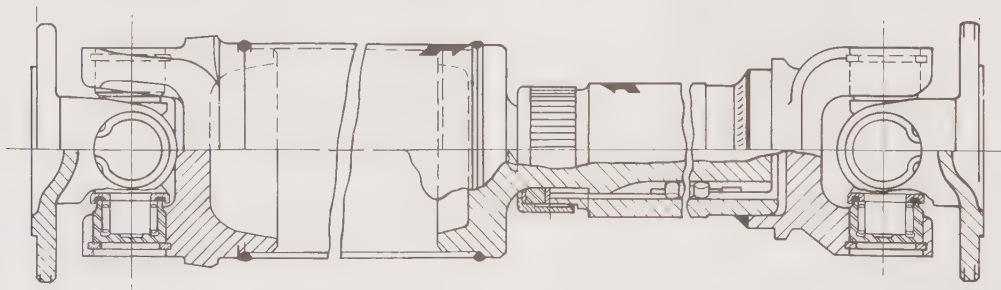


Fig 6:12 Propeller shaft with sliding splined portion.

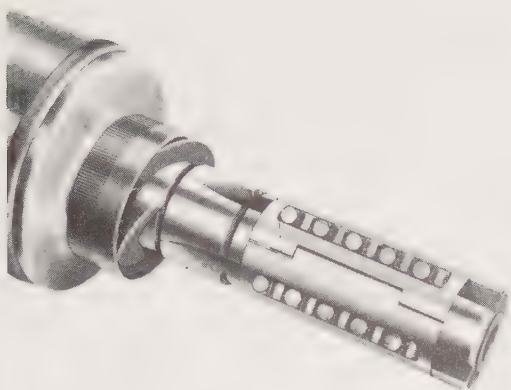


Fig 6:13 Linear roller bearings in telescoping splines.

mantled by first unscrewing the dust cap from the end of the yoke portion which carries the universal joint. The yoke must then be carefully slid off, at the same time collecting the forty rollers and the two curved retainer plates. Then take off the split stop washer, felt ring, washer and dust cap, in that order, from the machined spigot end of the propeller shaft. These parts are clearly shown on **FIG 6:16**.

When reassembling this joint, the felt ring must be soaked in engine oil before fitting. The dust cap and split washer are first assembled on the spigot, followed by the

felt ring and the split washer. The latter must be flattened with pliers to make it fit properly. Fill the grooves for the rollers with Duckhams grease No. Q.5648 or equivalent, and place the two restrainers in position. Through the restrainer slots, insert ten rollers into each of the four grooves. The arrows on yoke and shaft must now be aligned, and the yoke slid over the spigot, taking care that the rollers remain correctly positioned. When all is in order, screw the dust cap securely on to the end of the yoke.

The plain splines used on other telescopic shafts should be lubricated before reassembly, with the same type of grease as already stated, and the sealing ring should be soaked in oil. New felt sealing rings should be fitted whenever sliding type joints are dismantled.

To dismantle the strap-drive shaft (**FIG 6:14**) take out the four bolts which secure the connector straps to the yoke and tube coupling, and pull the end yoke clear of the tube. When reassembling, repack the bore indicated at Y on **FIG 6:15** with Duckham Q5648 or equivalent grease, and lubricate point X with Shell Dentax or Retinax A or similar. The assembly procedure is a reversal of dismantling, taking care to interleave the straps properly as shown on **FIG 6:14**.

6:6 Universal joints

When excessive wear takes place in the universal joints, the parts may be replaced; complete bearing sets should be used, and never individual components. The maker's set for each joint comprises needle bearing assemblies and snap rings, and centre journal (spider) complete with gaskets and retainers. These are the only parts subject to normal wear in service; the joint is shown dismantled on

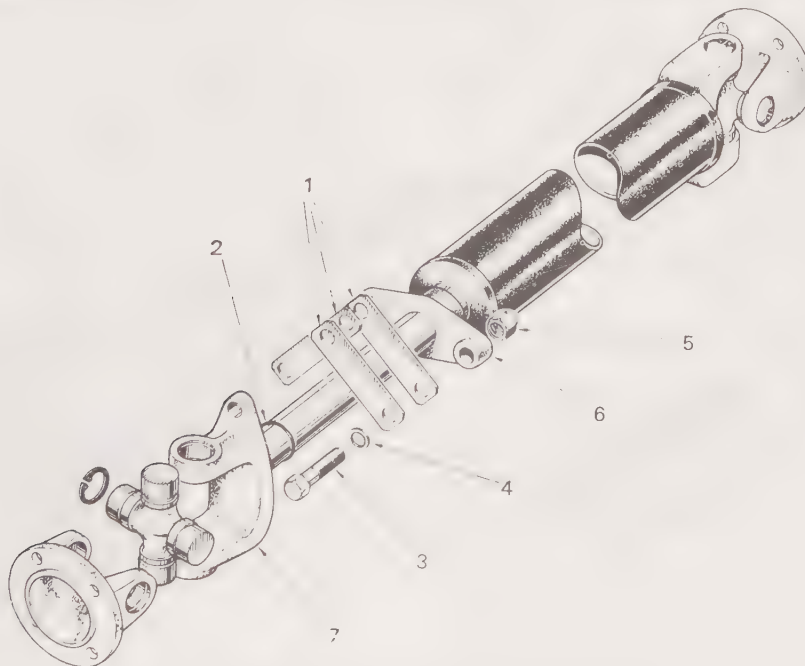


Fig 6:14 Exploded arrangement of strap drive propeller shaft.

Key to Fig 6:14
6 Tube coupling.

1 Connector straps.
7 End yoke.

2 Tube coupling 'O' ring.

3 Bolt for end yoke.

4/5 Washer and nut.

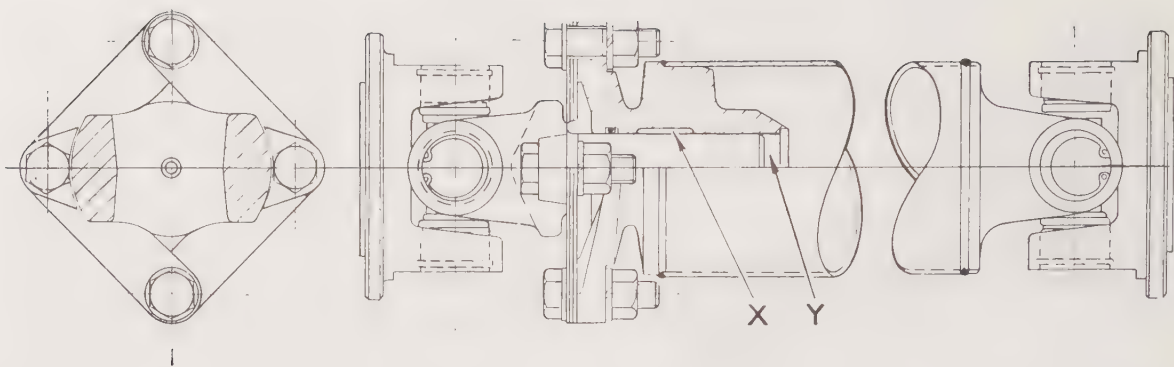


Fig 6:15 Strap drive propeller shaft (for X and Y refer to text.)

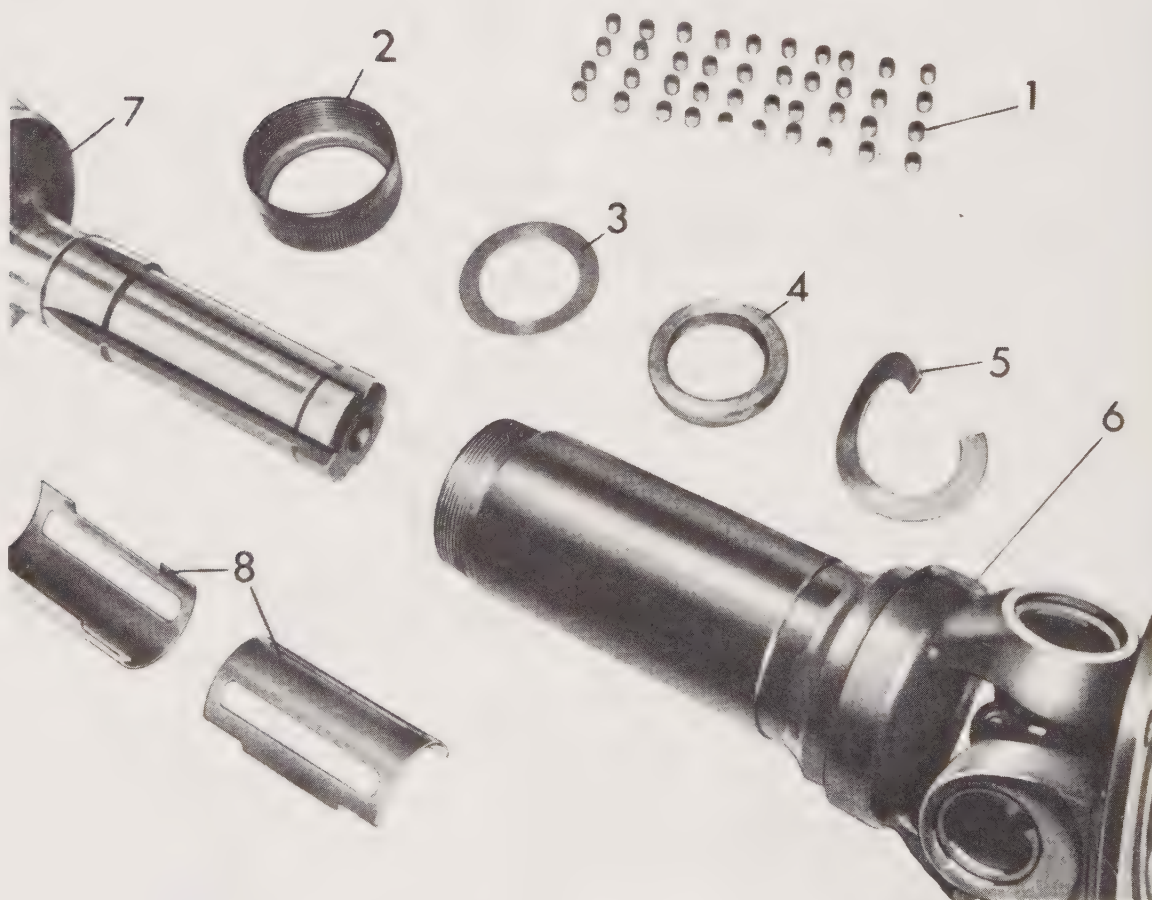


Fig 6:16 Components of linear roller bearing.

Key to Fig 6:16
8 Retainer plates.

1 Rollers. 2 Dust cap. 3 Washer. 4 Felt ring. 5 Split washer. 6 Yoke. 7 Propeller shaft tube.

FIG 6:17. It will be noted from this, that the snap rings, or circlips, are of a type best dealt with by using circlip pliers to avoid damage. These rings are first withdrawn by pinching their ends together and lifting out of the grooves. It may be found that the rings are caked with enamel or dirt adhering to the outside of the joint, and removal of this is essential as otherwise they may stick. Also, as the bearing assembly may be hard up against the ring laterally, a tap on the end of the position, at the particular side being dealt with as shown on **FIG 6:18**, will help to reduce end pressure on the ring. With the ring removed, gentle tapping on the radius of the fork will then cause the needle bearing assembly to emerge far enough to enable it to be pulled out by hand. This is best done from the bottom, with the bearing vertical, as this makes it easier to catch the needle rollers. The same operation is then repeated on the opposite bearing. This will leave the centre spider attached by its two bearings, and with two exposed journal faces where the first two bearings work. The spider should be supported in soft faces to avoid damage to those ground surfaces and the tapping process used on the other fork to remove its two races. A small-diameter drift can also be used if the races are really obstinate, as shown on **FIG 6:19**.

The spider with its four journals is now free and the bearings completely dismantled. All parts can be washed in petrol and inspected. If there is any sign of pitting, corrosion or abrasive wear, it is essential to replace the parts.

To reassemble, the races and rollers should be smeared with approved grease, sufficiently to keep the rollers positioned during assembly. The spider should next be refitted into the yoke of the flange. First position its gasket retainers at the bottom of the four journals with a little shellac varnish or other good jointing compound applied to the fork shoulders at this point to make a good seal. Tap the bearing assemblies into position with a soft drift, of a shade less diameter than the yoke-hole. Repeat this operation on the two bearings for the shaft fork. When all four races are firmly down, refit the circlips, making sure they are located right down in their grooves. The joint may appear tight in its articulating movement, but a few taps with a mallet on the yoke centre will remedy this, as it is simply due to the races being a little too far inwards. Finally apply a little shellac to the area of the circlips to discourage the entry of moisture.

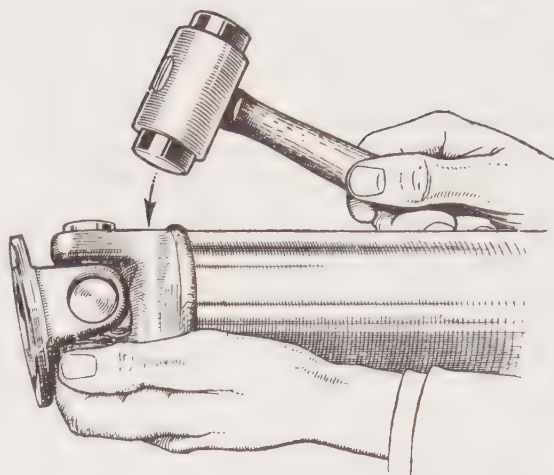


Fig 6:18 Method of 'jerking' roller bearing race from joint yoke

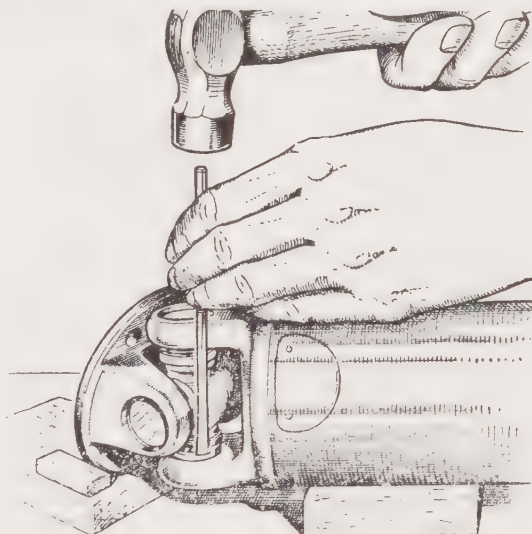


Fig 6:19 Use of drift for extracting bearing races if obstinate.

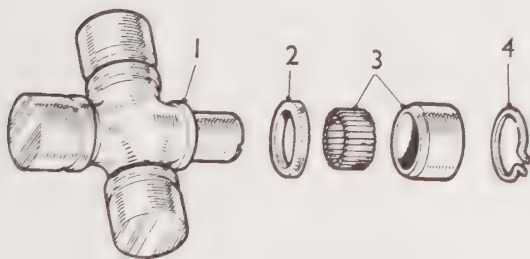


Fig 6:17 Universal joint bearing components.

Key to Fig 6:17 1 Spider. 2 Sealing ring. 3 Needle roller bearing. 4 Circlip.

It will be seen that renewal of the parts concerned will not compensate for wear in the bearing holes of the yoke forks. If for any reason these have worn oval or oversize, the complete yoke should be replaced and this of course means replacing its associated components. Wear on the spider journals is taken care of, as the replacement set includes this part.

It is important always to assemble the propeller shaft, if of the sliding-joint type, with the yokes on the long portion of the shaft in the same plane, as shown on **FIG 6:11**. As already mentioned, arrows indicate the correct position on the two splined portions, and this must not be overlooked when these are separated.

The shaft should also be replaced in the car with the sliding joint at the same end as when removed. This point

is emphasised, as at various times the 'works' positioning has varied as between front and rear.

6:7 Fault diagnosis

(a) Jumping out of gear

- 1 Broken spring behind selector rod locating ball
- 2 Excessively worn locating groove in selector rod
- 3 Worn coupling dogs
- 4 Selector fork loose on rod

(b) Noisy gear box

- 1 Insufficient oil

- 2 Excessive end play in gears
- 3 Worn or damaged bearings
- 4 Worn or damaged gear teeth

(c) Difficulty in engaging gear

- 1 Incorrect clutch pedal adjustment
- 2 Worn synchromesh cones

(d) Oil leaks

- 1 Damaged joint washers
- 2 Worn or damaged oil seals
- 3 Front, rear or side covers loose or faces damaged

CHAPTER 7

REAR AXLE AND SUSPENSION

- 7:1 Final drive removal
- 7:2 Outer axleshafts
- 7:3 Hub dismantling
- 7:4 Reassembly

- 7:5 Universal joints
- 7:6 Suspension spring
- 7:7 Shock absorbers
- 7:8 Fault diagnosis

The rear axle assembly comprises a final drive and differential unit having a four-point mounting to the chassis. At each side of this unit, a driving flange carries a universal joint of Hooke type. The axle shafts from the two joints comprise the main swing-axle suspension members, carrying the road-wheels on hubs at their ends. The suspension movement on each road wheel is thus in an arcuate path, with the arc radius at the centre of the universal joint. The outer ends of the axleshafts are carried in trunnion mounted bearing housings which are attached to vertical pressed steel links. A transverse leaf spring is attached at its outer ends to the top of each link, and has its centre rigidly fixed to the final drive housing. The spring and the axleshafts are thus approximately parallel to each other with the spring uppermost. From each vertical link, a tie-rod having flexible bushings at each end runs forward to an attachment bracket on the chassis, thus constraining the suspension in a fore-and-aft direction. Telescopic type hydraulic shock absorbers are fitted between the lower ends of the links and the chassis. The arrangement will be made clear from **FIGS 7:1** and **7:2**.

In the event of trouble with the differential and final drive assembly, it is advisable to remove the complete unit and send it for rectification, or replace with a service assembly. **FIG 7:3** shows the components.

7:1 Final drive removal

The unit is mounted on flexible rubber bushes as shown on **FIG 7:4**, there being two horizontal mounting lugs incorporated at the rear of the main housing, and a separate mounting plate bolted to the nosepiece of the pinion bearing housing; the plate is attached to the chassis by

two vertical mountings.

To remove the final drive unit the rear of the car must first be securely jacked up, the road wheels removed, and the brake pipes disconnected from the backplates (see Chapter 10). A jack is next placed under one of the vertical links, as shown on **FIG 7:5**, and screwed upwards until there is no load on the shock absorber. The nut and washer can then be removed from the lower attachment eye of the damper, the upper nut slackened, and the bottom of the shock absorber pulled clear of the mounting pin at the bottom of the vertical link. The two exhaust pipe brackets should next be released, and the rear propeller shaft flange uncoupled as described in Chapter 6. The jack is then transferred to the other side of the car, and used to jack up the vertical link on that side, while the damper is disconnected as before. The four bolts and nuts are next removed from each axle shaft coupling (**FIG 7:6**). Roll back the floor covering in the boot, which will reveal a cover giving access to the spring anchorage, which is integral with the final drive housing as shown on **FIG 7:7**. Unscrew the six nuts and take off the spring retaining plate. Next remove the three rearmost studs (from which the nuts were removed) from the final drive housing. The housing weight must now be supported by an assistant, and while so doing take off the nuts, washers and rubber bushes from the front attachment plate to the chassis (**FIG 7:3**). Remove the nuts and washers from the rear attachments, and withdraw the bolts. All the attachments are now free, and the final drive unit can be slid forward and downwards from under the car.

When replacing the unit, it should first be offered up to the rear mounting points, and the bolts fitted through the

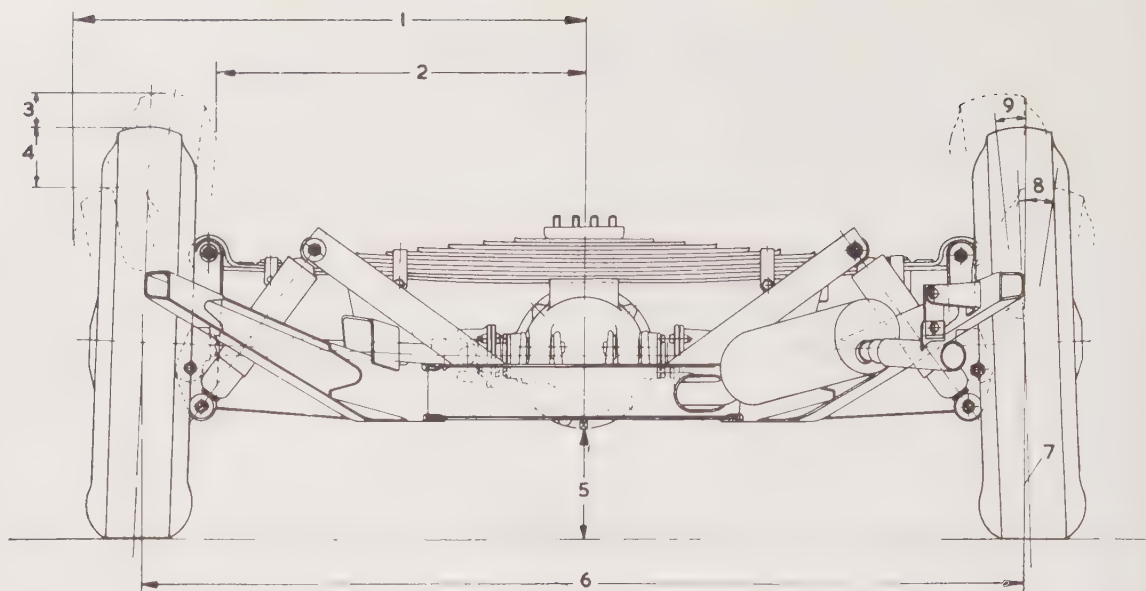


Fig 7:1 Arrangement of rear axle and suspension.

Key to Fig 7:1 1 Full rebound movement. 2 Full bump movement. 3 Movement static laden to bump. 4 Movement static laden to rebound. 5 Ground clearance. 6 Track. 7 Camber, static laden. 8 Camber, full rebound. 9 Camber, full bump.

lugs. The front rubber bushes are fitted next, taking care that the upper bushes are properly spigoted into the holes in the mounting plate; then fit the washers and nuts. Before fitting any of these four mountings, ensure that the rubber bushes are serviceable, and replace them if there is any doubt. The three spring attachment studs are then screwed into the top of the housing, and the spring plate and nuts refitted, as on **FIG 7:7**. Jack up each of the vertical links in turn, refit the axle shaft couplings and tighten the nuts to a torque of 24–28 lb/ft. Refit the lower damper attachments, tightening the nuts to a torque of 30–32 lb/ft. The upper damper nut must also be re-tightened to a torque of 42–46 lb/ft. Replace the exhaust pipe clamps and couple up the propeller shaft (see Chapter 6).

If it is desired to remove the differential unit from the casing, it is necessary first to remove the unit as already described, and then to withdraw the inner axleshafts complete with bearings. The bearing housings are each secured by four Allen screws as shown on **FIG 7:8**. To remove these, one of the holes in the coupling flange must be aligned with each of the screw-heads in turn so that an Allen key sized $\frac{3}{16}$ in (4.763 mm) can be pushed through the hole to engage the screw. When all the screws are withdrawn the complete assembly of inner axle shaft and bearings can be pulled out. The differential unit can then be taken out of the housing by removing the eleven bolts from the outer flange, when the assembly of final drive and differential can be withdrawn.

No further dismantling is advised, since special tools and jigs are necessary for correct reassembly. Exchange units should therefore be fitted in the event of trouble. The gears are pre-loaded, with adjustment for pre-load and mesh by means of shims. The pinion and the crown-wheel assembly run on taper roller bearings, while the inner axle shafts have ball bearings.

7:2 Outer axleshafts

From the universal joints at the differential casing, each of the main axleshafts runs straight to the road-wheel hub, its outer end being carried in needle-roller and ball-bearing races pressed into a housing which is trunnion-mounted on a bushed bolt passing through the lower end of each vertical suspension link, as shown in detail on **FIGS 7:2** and **7:9**. The brake anchor plate is also bolted to the bearing housing. The outer end of the axle shaft is tapered and keywayed, the wheel hub being located thereon by an end-nut covered by a hubcap.

If the axleshafts require removal for attention to the universal joints or hub bearings, the vehicle should first be jacked up as already described, and firmly supported. The procedure now to be described is followed on each side of the car. After removing the road-wheel and brake drum the flexible brake hose must be disconnected, and also the handbrake cable; reference should be made to Chapter 10 in regard to these and other brake components. Place a jack under the vertical link to relieve it of load, as described earlier. Referring to **FIG 7:6**, unscrew the four nuts and bolts from the universal joint flange, remove the nuts and bolts from the attachment eye of the radius arm, and detach the arm. Remove the upper shock absorber attachment bolt, and the nut and washer from the lower attachment, allowing the damper to be taken off.

Next carefully lower the jack until the load comes off the spring eye. Support the axle shaft end in such a manner that the nut and eyebolt can be removed from the spring eye. The vertical link is now free, and can be removed complete with the axle shaft assembly.

7:3 Hub dismantling

To detach the hub, an extractor is required, the standard type being Churchill No. S109. This is used after removing the hubcap and shaft-end nut; access is now given to the four setscrews which secure the grease trap and brake

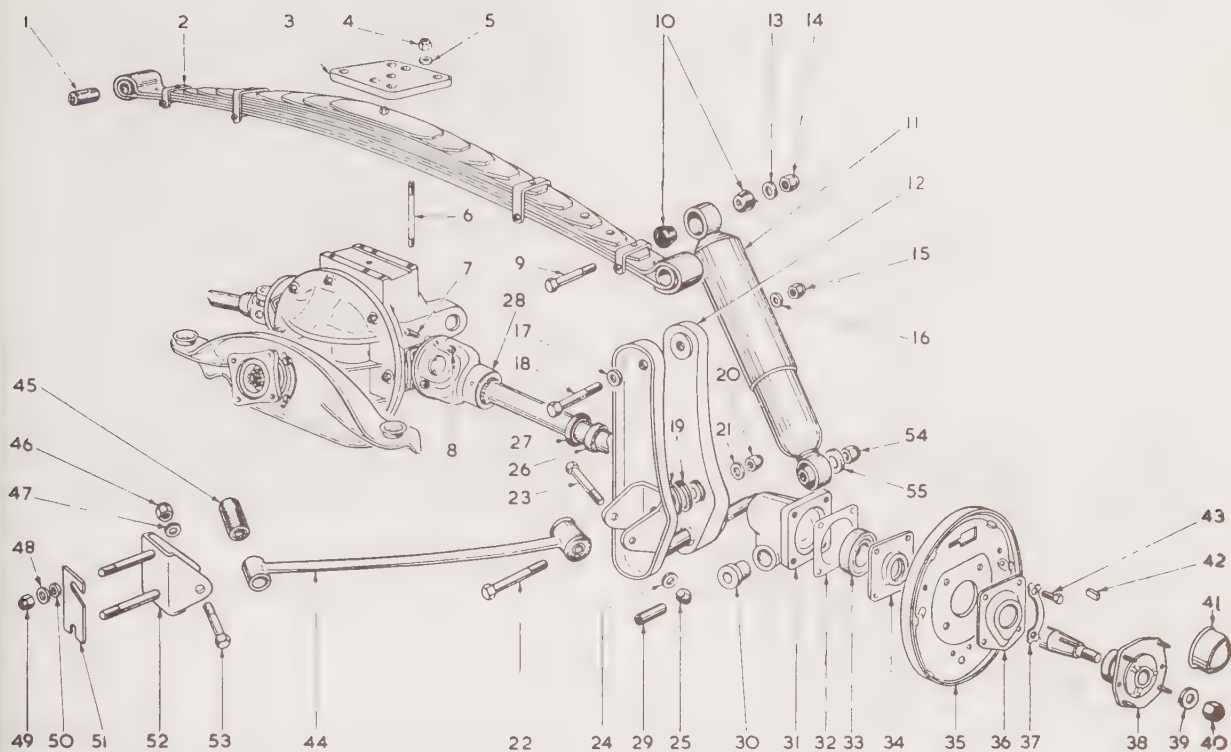


Fig 7:2 Components of rear axle and suspension.

Key to Fig 7:2 1 Metalastik bush. 2 Road spring. 3 Clamp plate. 4 Nyloc nut. 5 Plain washer. 6 Stud. 7 Bolt. 8 Nyloc nut. 9 Bolt. 10 Rubber bush. 11 Damper. 12 Vertical link. 13 Plain washer. 14 Nyloc nut. 15 Nyloc nut. 16 Plain washer. 17 Plain washer. 18 Bolt. 19 Rubber seal. 20 Nyloc nut. 21 Plain washer. 22 Bolt. 23 Bolt. 24 Plain washer. 25 Nyloc nut. 26 Seal. 27 Flinger. 28 Axle shaft. 29 Steel sleeve. 30 Flanged nylon bush. 31 Trunnion housing. 32 Gasket. 33 Ball race. 34 Seal housing. 35 Brake backplate. 36 Grease retainer. 37 Locktab. 38 Hub. 39 Plain washer. 40 Nyloc nut. 41 Hub cap. 42 Key. 43 Setscrew. 44 Tie-rod. 45 Metalastik bush. 46 Nyloc nut. 47 Plain washer. 48 Plain washer. 49 Nyloc nut. 50 Plain washer. 51 Shim. 52 Tie-rod bracket. 53 Bolt.

backplate, as shown on FIG 7:10. After unscrewing these, the trap and backplate can be withdrawn followed by the grease seal housing and seal.

To detach the vertical link from the bearing housing, remove the nut from the trunnion bolt, and withdraw the bolt. Note when detaching the trunnion that the bolt carried a steel bush with rubber and nylon inserts, and these must be reassembled in the correct order.

If the axleshaft bearings require attention, the outer ball race can be removed by means of an extractor, the standard type being Churchill tool No. S4221A. This is applied after first pushing the trunnion as far as it will go along the shaft, so causing the outer race to protrude from the housing. The bearing may then be drawn from the shaft and housing, and the shaft pulled out of the trunnion.

To remove the roller bearing and oil seal, a suitable drift is necessary (Churchill tool No. S300). The trunnion should be put on a suitable block, and the oil seal drifted out. The trunnion is then inverted, so that its flange rests on the block, and the needle roller bearing is drifted out towards the flange, when it can be removed. Note FIG 7:11 for location of components.

After cleaning all parts, the axleshaft end should be carefully examined for cracks, and for wear on the key and keyway, taper, and oil seal contact face. The shaft should also be tested for straightness. If any defects are found the shaft should be replaced; this includes wear in the yoke of the universal joint (to be described later). If the ball and roller bearings are chipped, worn or otherwise defective, they must be replaced. The hub taper should be a snug fit on both the shaft and key, and must be free from cracks or undue wear on the oil seal contact face.

7:4 Reassembly

To reassemble the bearing housing, the drift and extractor already mentioned are required, the latter now being used as a press. With this equipment, press the needle roller bearing, radiused end leading, into the trunnion. (The correct end of the bearing can be verified by noting that the lettered end is the one which is visible when applying the press.) The bearing is pressed in to a depth of 0.5 in (12.7 mm) from the trunnion face, as shown on FIG 7:11. The inner oil seal is then drifted into the trunnion with its

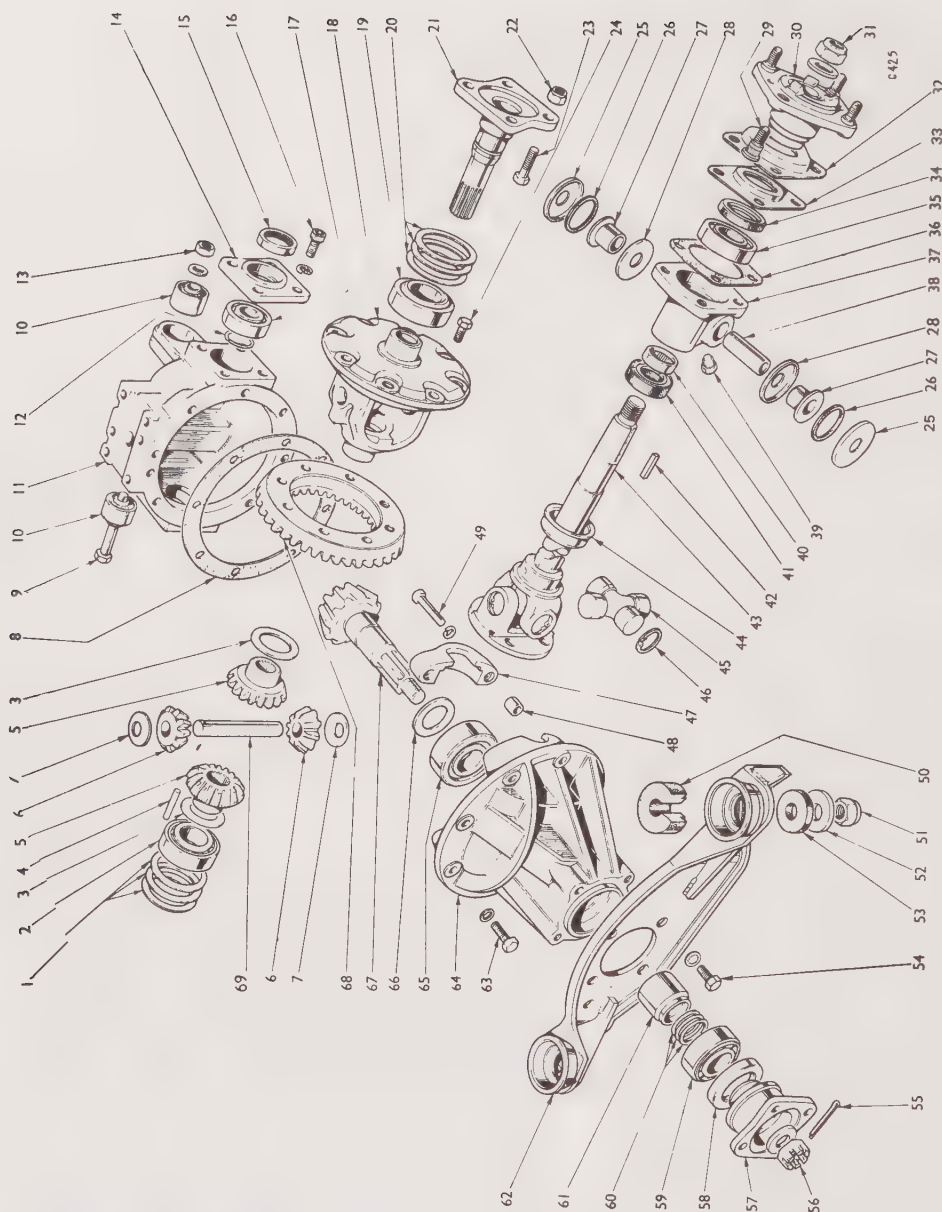


Fig 7 : 3 Components of differential unit and axle.

- Key to Fig 7 : 3**
- 1 Shim.
 - 2 Differential side bearing.
 - 3 Thrust washer.
 - 4 Cross-shaft locking pin.
 - 5 Sun gear.
 - 6 Planet gear.
 - 7 Thrust washer.
 - 8 Joint washer.
 - 9 Rear mounting bolt.
 - 10 Metalastik bush.
 - 11 Hypoid rear casing.
 - 12 Circlip.
 - 13 Nyloc nut.
 - 14 Seal housing plate.
 - 15 Oil seal.
 - 16 Hexagon socket screw.
 - 17 Ball race.
 - 18 Differential carrier.
 - 19 Differential side bearing.
 - 20 Shims.
 - 21 Inner axle shaft.
 - 22 Nyloc nut.
 - 23 Bolt.
 - 24 Bolt.
 - 25 Shim.
 - 26 Rubber sealing ring.
 - 27 Nylon bush.
 - 28 Shim.
 - 29 Stud.
 - 30 Hub.
 - 31 Nyloc nut.
 - 32 Grease trap.
 - 33 Outer seal housing.
 - 34 Seal.
 - 35 Ballrace.
 - 36 Joint washer.
 - 37 Trunnion housing.
 - 38 Distance tube.
 - 39 Grease plug.
 - 40 Needle roller bearing.
 - 41 Inner oil seal.
 - 42 Key.
 - 43 Outer axle shaft.
 - 44 Grease flinger.
 - 45 Universal joint assembly.
 - 46 Circlip.
 - 47 Bearing cap.
 - 48 Tubular dowel.
 - 49 Bolt.
 - 50 Mounting rubber.
 - 51 Nyloc nut.
 - 52 Plain washer.
 - 53 Rubber pad.
 - 54 Bolt.
 - 55 Split-pin.
 - 56 Pinion head bearing.
 - 57 Pinion tail bearing.
 - 58 Oil seal.
 - 59 Pinion tail bearing.
 - 60 Shims.
 - 61 Spacer.
 - 62 Mounting plate.
 - 63 Bolt.
 - 64 Hypoid nose piece casing.
 - 65 Pinion head bearing.
 - 66 Spacer.
 - 67 Pinion.
 - 68 Crownwheel.
 - 69 Cross-shaft.
 - 70 Bolt.
 - 71 Lockplate.
 - 72 Brake backplate.
 - 73 Bolt.
 - 74 Nyloc nut.
 - 75 Vertical link.

Note. * New trunnion sealing details introduced from Commission No. 'Spitfire', FC62167; 'Vitesse', HB28055.

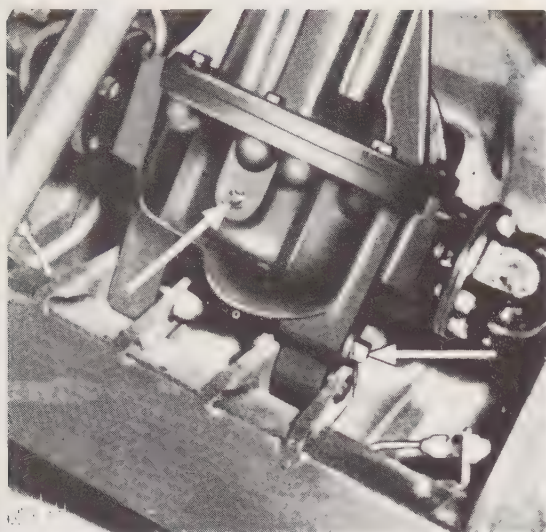


Fig 7:4 Underside of differential unit, showing mounting attachments. Arrows indicate filling and drain plugs.

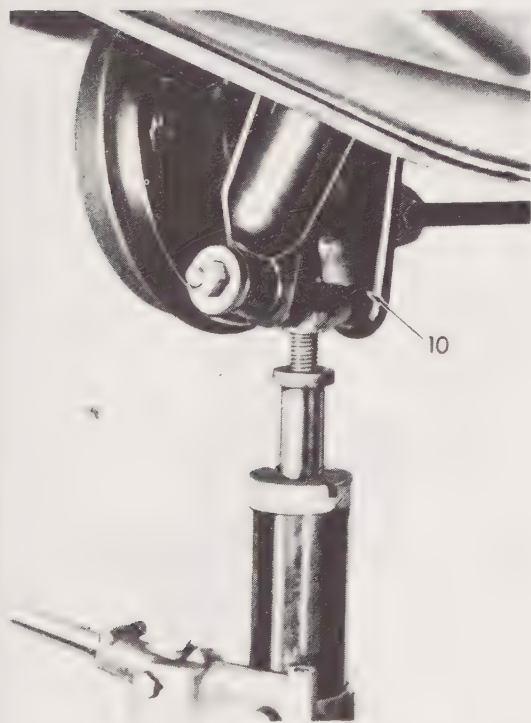


Fig 7:5 Jack positioned under vertical link to take weight when detaching shock absorber.

sealing lip trailing; that is, the lips should face the car centre-line. Next pack the rollers with approved grease, and slide the axleshaft into the housing and through the bearing oil seal and bearing, taking care that it enters squarely so as not to damage the lips of the seal. Insert a quantity of grease into the trunnion housing from the outer end but do not pack it tightly; about half-full is sufficient.

The axleshaft with trunnion positioned should now be clamped in a vice between smooth jaws that will not mark the shaft. Pack the ball bearing with approved grease, pass it over the tapered shaft end, and drift it on to the shaft and housing until it is properly home.

Fit a new oil seal if required into the outer seal housing. When fitting this housing to the trunnion flange, use a new paper washer, and make sure that the faces are perfectly clean and flat. After replacing the brake backplate and grease trap, the four bolts should be tightened to a torque of 16–18 lb/ft. Before fitting the road-wheel hub, check the fit of the key in both the keyways, and if not tight and snug, fit a new one, carefully filed to fit on all sides. When the hub is properly fitted to the shaft taper, replace the washer, screw on the end nut and tighten it to a torque of 110 lb/ft.

To reassemble the vertical links to the trunnion housing, note carefully the positions of the various bushes on the trunnion bolt as shown on **FIG 7:10**. Position the two rubber seal rings, and fit the bolt through the bushes and steel sleeve to unite the vertical link-plates and housing. Tighten the outer nut on the bolt to a torque of 42–46 lb/ft. The shaft and vertical link assembly is then ready for installation on the car.

7:5 Universal joints

The universal joint on each axleshaft (**FIG 7:12**) is of similar type to that described for the propeller shaft in Chapter 6. With the shaft removed, it is quite easy to check for wear, by holding the shaft in a smooth-jaw vice and trying to pull, rock or turn the driving flange. If wear is present, renewal of the needle roller bearings is called for. This is carried out as already described in Chapter 6, the same assembly of components being supplied by dealers for rectification. Wear in the yoke-holes of the axleshaft or driving flange forks can however only be remedied by replacing the part concerned; it is not possible to separate the axleshaft splines from the fork.

7:6 Suspension spring

The transverse leaf spring (**FIG 7:13**) varies in construction according to the type of car, the number of leaves ranging from 7 to 12. Full details will be found in the Appendix. If it is desired to remove the spring, this must only be done after the car has been supported as already described, the drive shafts disconnected at the universal couplings, and the shock absorbers removed, all as detailed earlier.

The nuts are then unscrewed from the spring-eye bolts and the bolts withdrawn, as shown on **FIG 7:14**. With the access plate over the central spring anchorage removed, take off the six nuts and the clamp plate. Then withdraw the three front studs which screw into the final drive housing. (This can readily be done by fitting two nuts on to the top threads, locking them against each other and applying a spanner to the lower one.) The spring can then be taken out from one side of the car.

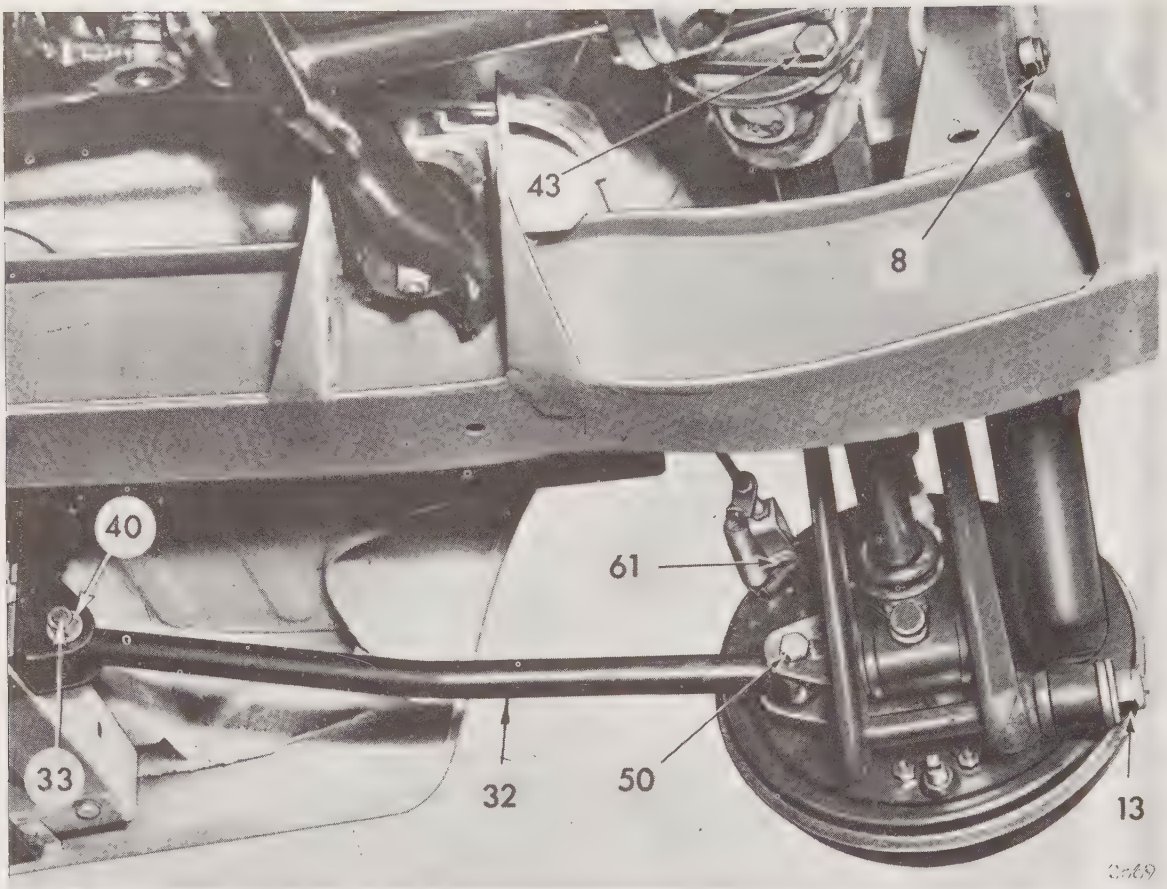


Fig 7:6 Axleshaft coupling and suspension details.

Key to Fig 7:6 8 Nyloc nut. 13 Lower damper attachment. 32 Tie-rod. 33 and 40 Tie-rod attachment. 43 Coupling bolts. 50 Rear attachment of tie-rod. 61 Handbrake lever clevis.

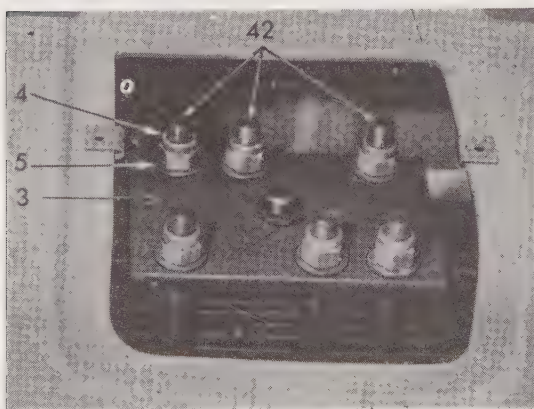


Fig 7:7 Centre anchorage of main suspension spring, with access cover removed.

Key to Fig 7:7 3 Retaining plate. 4 Nut. 5 Washer. 42 Rear studs.

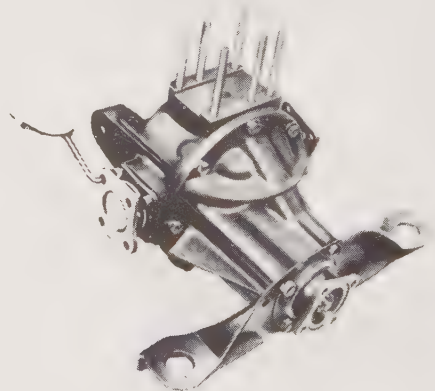


Fig 7:8 Differential unit showing method of unscrewing screws from inner axle shaft bearing housings.

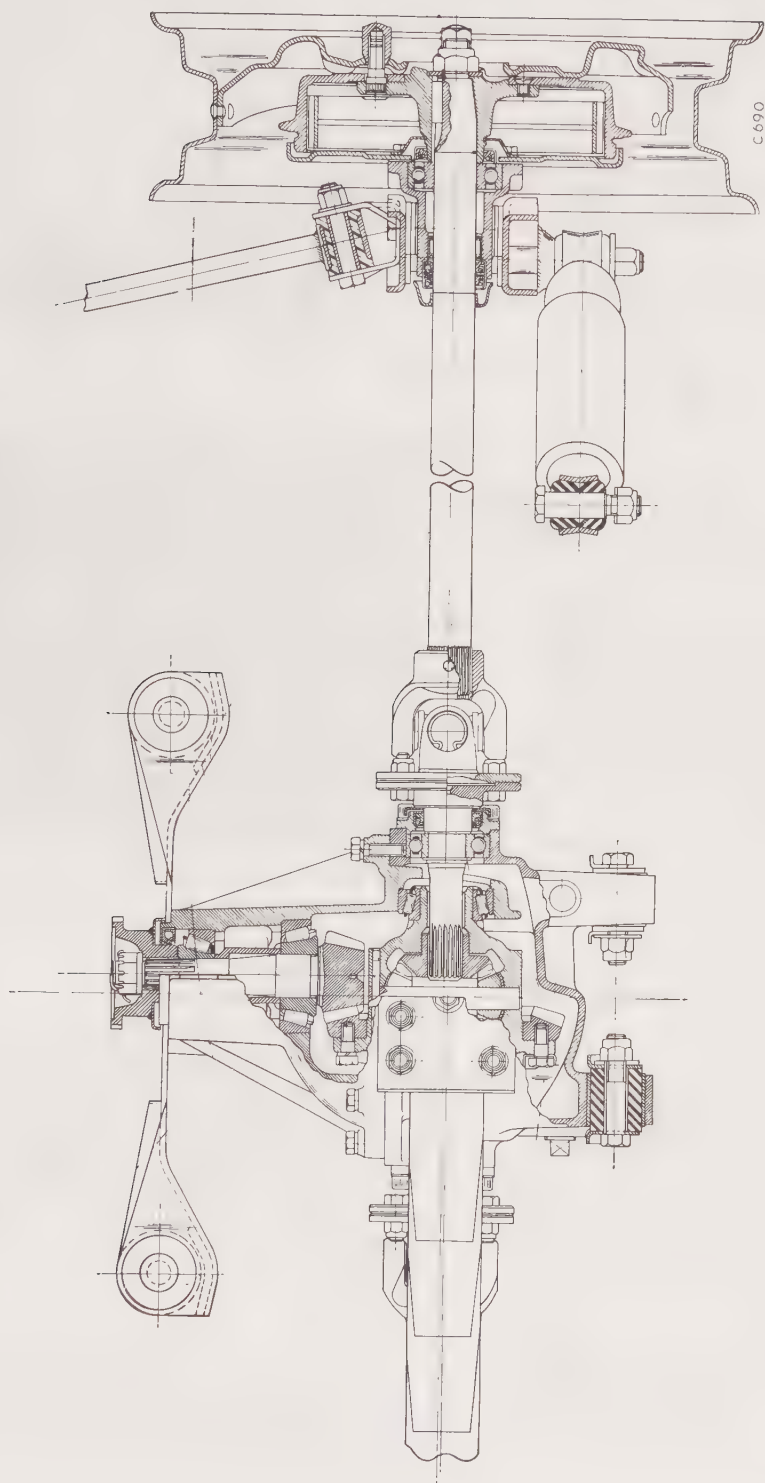


Fig 7 : 9 General arrangement of axle/shaft and hub assembly.

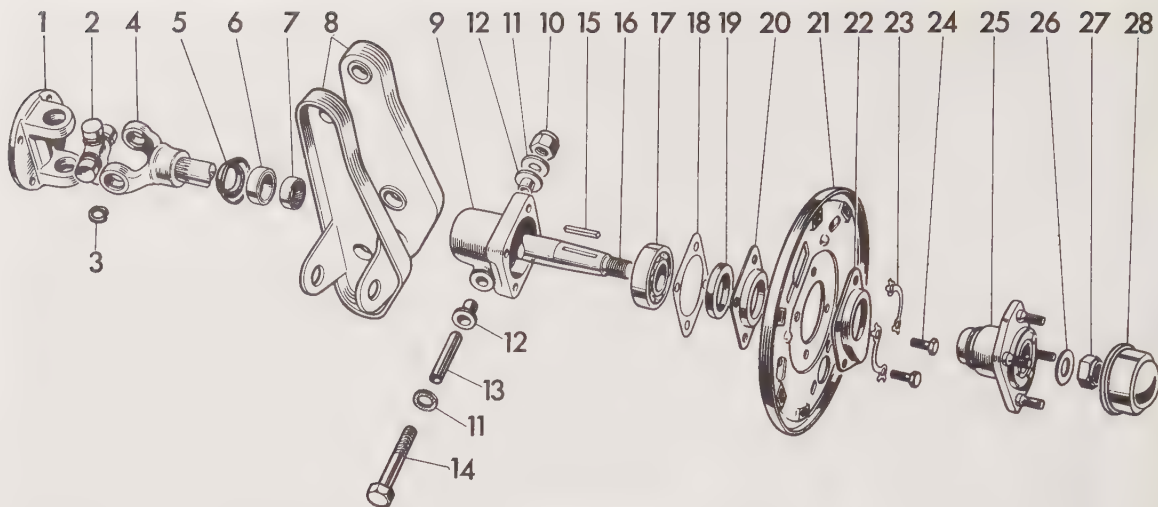


Fig 7:10 Components of vertical suspension link, axleshaft and hub.

Key to Fig 7:10 1 Inner yoke. 2 Needle roller and spider assembly. 3 Circlip. 4 Outer axle shaft yoke. 5 Flinger. 6 Inner oil seal. 7 Needle roller bearing. 8 Vertical link. 9 Trunnion housing. 10 Nyloc nut. 11 Rubber seal. 12 Nylon bush. 13 Steel bush. 14 Bolt. 15 Hub driving key. 16 Axle shaft. 17 Ball race. 18 Paper joint. 19 Outer oil seal. 20 Outer seal housing. 21 Brake backing plate. 22 Grease trap. 23 Lockplate. 24 Bolt. 25 Hub. 26 Plain washer. 27 Nyloc nut. 28 Hub cap.

When replacing the spring, make sure that the spigot-head on its centre bolt locates properly in the recess in the final drive housing. When assembling the suspension, the spring-eye bolts must only be tightened lightly at first. Final tightening to a torque of 42–46 lb/ft must be done with the car in its static laden condition; this ensures that the bushes are not stressed in one direction. These bushes must be replaced if they show signs of wear, this also applying to bushes of similar type in other parts of the linkage. After replacing the clamp plate at the spring centre

(FIG 7:7), tighten the six nuts to a torque of 28–30 lb/ft. Before replacing the access plate, apply a good sealer liberally to the plate edge, and tighten the four screws evenly. The radius arms have renewable rubber bushes, and their chassis brackets are fitted with shims for adjustment. If the brackets are removed, make sure that the shims are replaced as taken off. The shims are used when adjusting wheel alignment, but if this is thought to be necessary for any reason, an agent should be consulted, as accurate measuring equipment is necessary. Both the

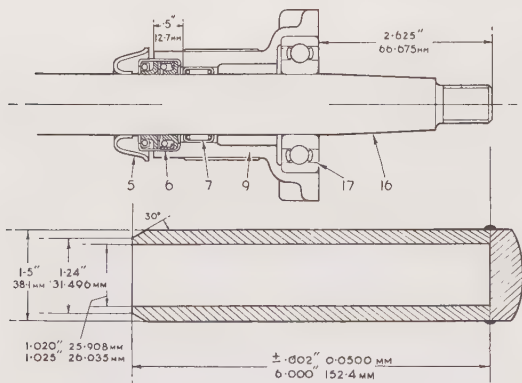


Fig 7:11 Details of hub bearings, and hollow drift for refitting oil flinger to axleshaft.

Key to Fig 7:11 5 Oil flinger. 6 Seal. 7 Roller bearing. 9 Hub shell. 16 Shaft taper. 17 Ball bearing.

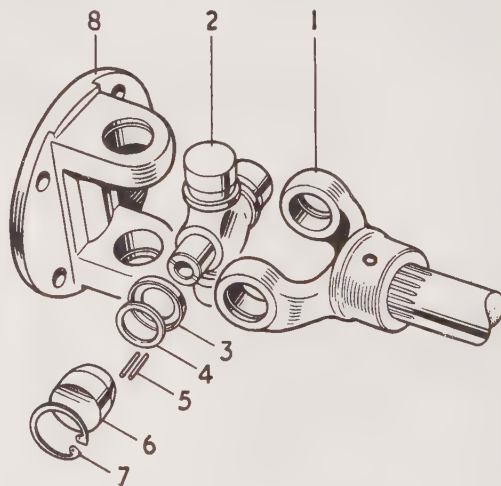


Fig 7:12 Axleshaft universal joint dismantled.

Key to Fig 7:12 1 Yoke. 2 Spider. 3 Seal retainer. 4 Seal. 5 Rollers. 6 Roller race. 7 Circlip. 8 Flanged yoke. (Seal retainer is deleted on later types.)

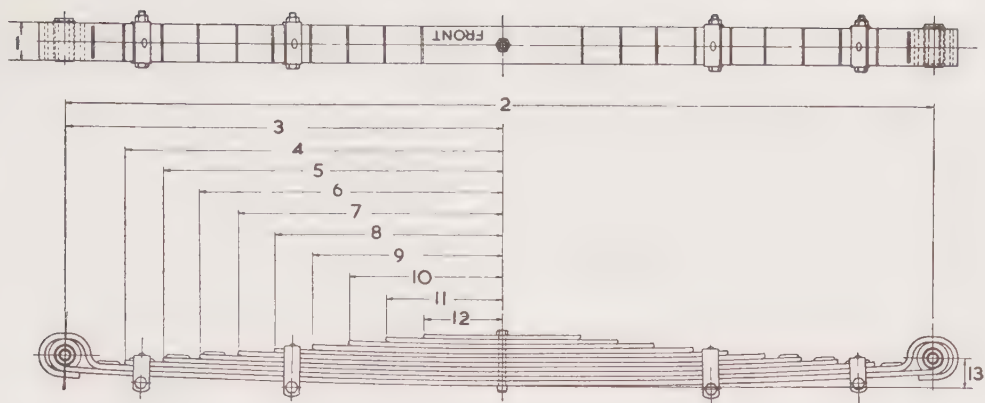


Fig 7:13 Arrangement of suspension leaf-spring, and numbering of leaves which varies according to type.

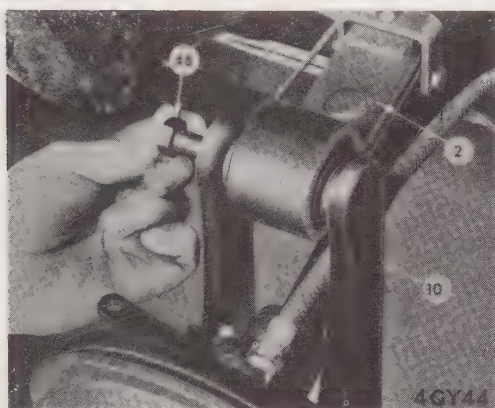


Fig 7:14 Removal of spring-eye bolt when detaching spring.

Key to Fig 7:14 2 Spring. 10 Vertical link. 46 Eye-bolt.

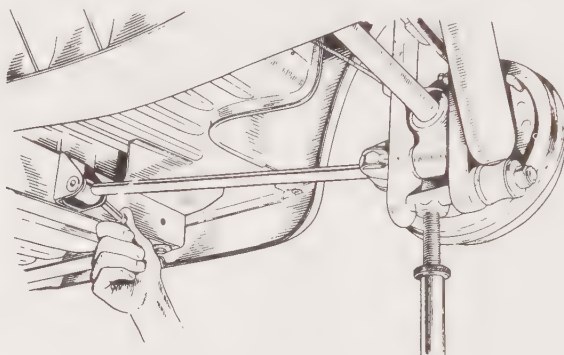


Fig 7:15 Refitting tie-rod bolts, using jack to assist by adjusting height.

bracket-bolt nuts and the eye attachment nuts are tightened to a torque of 24–26 lb/ft. It may be necessary to raise or lower the chassis a little in order to insert the eye-bolt through the chassis bracket end of the radius arm, as shown on **FIG 7:15**.

It will be noted that throughout the suspension system, a large number of Nyloc stiff-nuts are used. These will stand quite a lot of removal and replacing without losing their 'stiff' quality, but if any appear to be unduly slack, they must be replaced; inherent locking is an essential feature.

7:7 Shock absorbers

Inadequate damping of the suspension may be due in part to incorrect tyre pressures or worn bushes, and such matters must be investigated before it is assumed that faulty shock absorbers are the cause. When the latter have been removed as already detailed, a simple check on them

can be made.

The shock absorber is positioned vertically with its bottom eye clamped between two pieces of hardwood in the vice jaws. The upper piston-rod is held firmly by the hands and moved up and down. If there is a lack of resistance at the commencement of the stroke, or possibly a springy feel, this is a strong indication that air is present. The shock absorber should then be left in the vice for a short time, which will induce the air bubbles to pass to the top of the body chamber and collect there. Following this pause, the piston-rod should then be given a few short strokes from the fully-compressed position, followed by several slow strokes for the full length of travel; this procedure should remove all the collected air. If the shock absorber is now air-free, a moderate and even pressure should be apparent throughout the length of both outward and inward movement of the piston. If the resistance is erratic, and there is suspicion of free movement with

negligible resistance or even none at all, the shock absorber must be replaced. In carrying out this hand test, a real guide to operational conditions is difficult to obtain without a lot of experience, because of the slow speed of piston movement in comparison with that which obtains in practice. This slow speed only partially operates the 'bleed' setting inside the body, on which control of the suspension depends. Therefore if a new shock absorber is tested by hand, a low resistance to slow movement must not be taken as evidence of a fault; the 'feel' over the full stroke is a much more reliable guide, evenness much more significant than tightening up over a shorter movement.

7:8 Fault diagnosis

(a) Noisy axle

- 1 Insufficient or incorrect lubricant
- 2 Worn bearings
- 3 Worn gears

(b) Excessive backlash

- 1 Worn gears, bearings or bearing housings
- 2 Worn shaft splines

- 3 Worn universal joints
- 4 Loose or broken wheel studs. Worn wire wheel hub splines

(c) Oil leakage

- 1 Defective seals in hub
- 2 Defective pinion shaft seal
- 3 Defective seals on universal joint spiders

(d) Vibration

- 1 Propeller shaft out of balance
- 2 Worn universal joint bearings

(e) Rattles

- 1 Rubber bushes in suspension worn
- 2 Dampers loose
- 3 Spring clips loose
- 4 Loose spring attachment
- 5 Worn bushes in spring eyes
- 6 Broken spring leaves

(f) 'Settling'

- 1 Weak or broken spring leaves
- 2 Badly worn pins and bushes

CHAPTER 8

FRONT SUSPENSION AND HUBS

- 8:1 Spring removal**
- 8:2 Shock absorbers**
- 8:3 Sub-assembly**
- 8:4 Suspension dismantling**

The independent front suspension comprises a pair of coil spring and hydraulic shock absorber units, in conjunction with a wishbone system. Each of the suspension units is mounted on a steel sub-frame attached to the side member of the chassis, the general arrangement being as **FIGS 8:1 and 8:2**. An exploded view of the components is shown on **FIG 8:3**. Each of the wishbone assemblies is pivoted on rubber bushes at its inner ends. The top wishbone is attached at its outer end to the top of the vertical steering link, by means of a ball and socket joint which caters for both up and down and steering movement. The lower wishbone carries a bronze trunnion at its outer end, on a Nylon-bushed bearing. The lower end of the vertical link also terminates at this point in a threaded bearing shank which is screwed into the trunnion. An oil reservoir in the base of the trunnion ensures constant lubrication of this bearing, and is the only item requiring oil replenishment at long intervals; all other bearings and joints are of a type which do not call for lubrication.

The combined spring and damper units are located between the outer ends of the lower wishbones, and an abutment plate at the top of the sub-frame. An anti-roll bar is attached to the lower wishbones by links, and is carried in bushes on the front of the chassis.

8:1 Spring removal

The spring and damper unit can be removed without taking down the whole of the suspension, and in the event of spring breakage, dimensional inaccuracy, or faulty damper operation, it is recommended that exchange units be substituted. The car should first be supported at the front on stands, and the road-wheels removed. The

- 8:5 Rubber bushes**
- 8:6 Front hubs**
- 8:7 Anti-roll bar**
- 8:8 Fault diagnosis**

nuts are next unscrewed from the anti-roll bar attachments to the wishbones, leaving the bar to swing free. Remove the three nuts securing the upper spring pan to the abutment plate on the sub-frame (see **FIG 8:4**). Take off the nut from the eyebolt attaching the lower end of the damper to the wishbone, and withdraw the eyebolt, at the same time supporting the brake and hub. The spring and damper unit may then be taken from the assembly.

When reassembling, the brake and hub must be supported, and the spring unit entered from below and passed upwards until the three studs locate in the holes in the abutment plate of the sub-frame. Fit the eyebolt to the lower eye of the damper, and replace the washers and nuts.

8:2 Shock absorbers

If the dampers are defective, they may be removed from the springs for replacement. It is necessary to compress the spring in a suitable press, in order to take the load off the nuts which secure the upper end of the damper body in the spring pan. When this is done, unscrew the locknut and nut from the damper top, and remove the washer and rubber bush. The spring can then be carefully released to its full length, and the damper withdrawn from the upper spring pan and spring. On Woodhead-Monroe dampers only, the lower spring pan is secured to the damper body by a pair of collets, and can be removed by pushing it upwards and taking out the collets.

When refitting the dampers, make sure that all parts are correctly positioned as on **FIG 8:5**. Fit the washer and rubber buffer to the top shank, and the collets and lower spring pan (on Woodhead-Monroe type only). The

damper is then fully extended, and inserted through the spring and into the top spring pan, with its shank entering the hole. The spring must then be compressed so that the top end of the damper can be finally positioned, with the second rubber buffer, washer and two nuts replaced; the spring may then be released.

When the dampers are removed their action can be tested in the same manner as described for the rear dampers, Chapter 7.

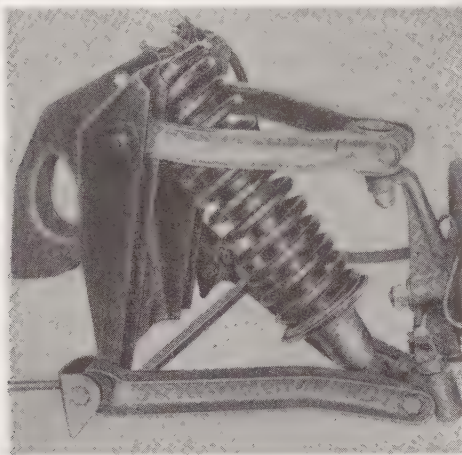


Fig 8:1 Arrangement of front suspension unit and hub.

8:3 Sub-assembly

If it is required to remove a complete suspension sub-assembly from the car, the procedure is the same whichever side is dealt with. The car is first supported on stands at the front, and the road-wheel removed. If the assembly on the driver's side is to be removed, the steering column impact clamps must be slackened and the column withdrawn from the coupling. Reference should also be made to Chapter 9 in this respect. The brake hoses are also disconnected as detailed in Chapter 10. Next take out the nut and bolt securing the engine side-valance to the suspension sub-frame. Disconnect the anti-roll bar from the lower wishbone, as described earlier. With an extractor, uncouple the steering tie-rod end from the steering arm after removing its nut and washer, the standard extractor is Churchill tool No. S160.

The fulcrum brackets of the front and rear lower wishbones have adjustment shims between them and the chassis frame, as shown on **FIG 8:6**. Remove the nuts and washers from the fulcrum brackets, and take care of the shims. The sub-frame is attached by four bolts and tapping plates at its outer face, and a single bolt at the inner end. When these are removed the sub-frame complete with suspension assembly can be taken from the car.

When replacing the assembly, first fit the lower wishbone fulcrum bracket studs through their chassis holes, and fit the nuts loosely. Insert the shims, taking care that they are in their original positions and properly located, and then tighten the nuts. The sub-frame is next positioned to the chassis, and secured with the single inner attach-

ment bolt. The four outer bolts can then be fitted along with their tapping plates. All these bolts must then be tightened evenly to a torque of 26–28 lb/ft. The anti-roll bar link is refitted to the lower wishbone, the brake hose replaced, and the brakes bled in accordance with Chapter 10. Reconnect the steering column if this has been uncoupled, and tighten the clamp. Secure the engine valance to the sub-frame, and replace the road-wheels.

The shims fitted at the lower wishbone pivots are used for adjustment of the steering geometry. If there is reason to suspect the accuracy of any of these important dimensions it is essential to have them checked by an agent equipped with the correct measuring devices.

8:4 Suspension dismantling

The suspension may be dismantled without removing the sub-frame and assembly from the car; and this procedure will now be described. If the unit has been removed complete as detailed earlier, the applicable information will serve. Additional information regarding the brake assemblies is given in Chapter 10, and this should be referred to before dismantling any part of this mechanism.

First remove the spring and shock absorber as already detailed. Take off the brake disc and caliper, remove the hub cap, and extract the split-pin from the end of the stub axle. Unscrew the nut and draw off the hub assembly from the stub axle. After bending back the tabwashers, remove the four nuts and bolts which secure the steering arm, caliper bracket and dust shield. These items can then be removed from the vertical link. The two nuts and pivot bolts securing the inner ends of the upper wishbones to the sub-frame are next taken off, and the nuts removed from the lower inner fulcrum brackets of the lower wishbones. (Note previous remarks regarding the shims when detaching these brackets.) The vertical link and wishbone assembly can then be withdrawn from the car.

To separate the upper wishbones from the top of the vertical swivelling link, an extractor is necessary, the standard type being Churchill tool No. S166A. The nut and washer are first removed from the underside of the link eye (see **FIG 8:7**). The ball joint can then be extracted. The ball joint assembly is removed from the wishbones by taking out the two nuts and bolts and the two wishbone arms will then separate.

From the lower trunnion assembly, remove the pivot bolt uniting the trunnion to the outer ends of the wishbones. Note that the bolt carries a steel bush, and two Nylon bushes and sealing washers; this is clarified on **FIG 8:8**. The trunnion can then be unscrewed from the threaded bearing shank of the vertical link. If the stub axle is damaged and requires replacement, it must be pressed out of the vertical link after removing the nut.

8:5 Rubber bushes

If the rubber bushes at the inner ends of the wishbones require replacement, the new bushes must be pressed in correctly after removal of the worn ones. This calls for a suitable press for removal and replacement, along with a pilot tool to ensure that the bush is fed properly into the wishbone eye. When fitted, the bushes should protrude for an equal distance at each end of the eye, as shown on **FIG 8:9**. Any component parts of the fulcrum of the

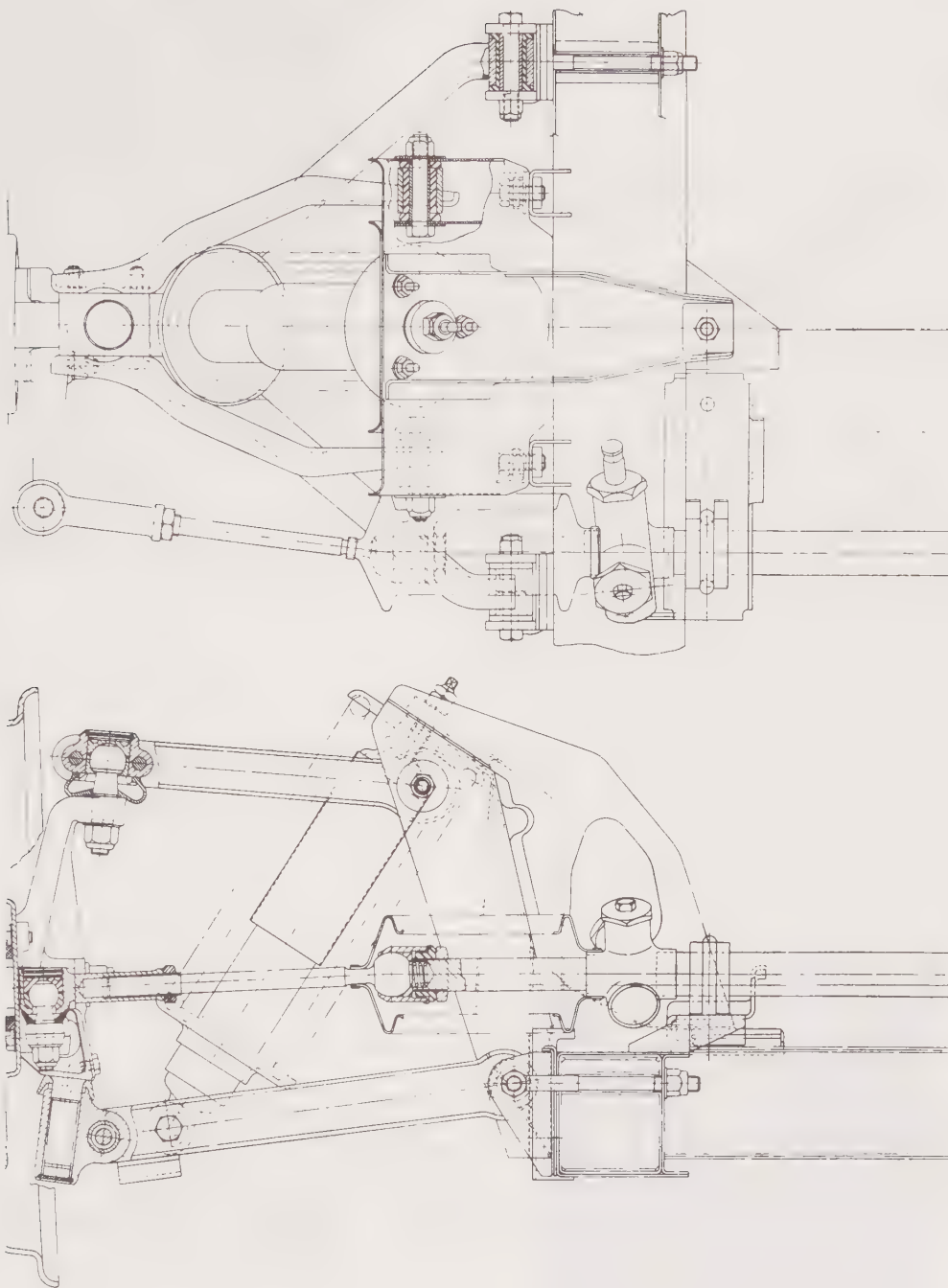


Fig 8:2 Layout of suspension links and steering joints.

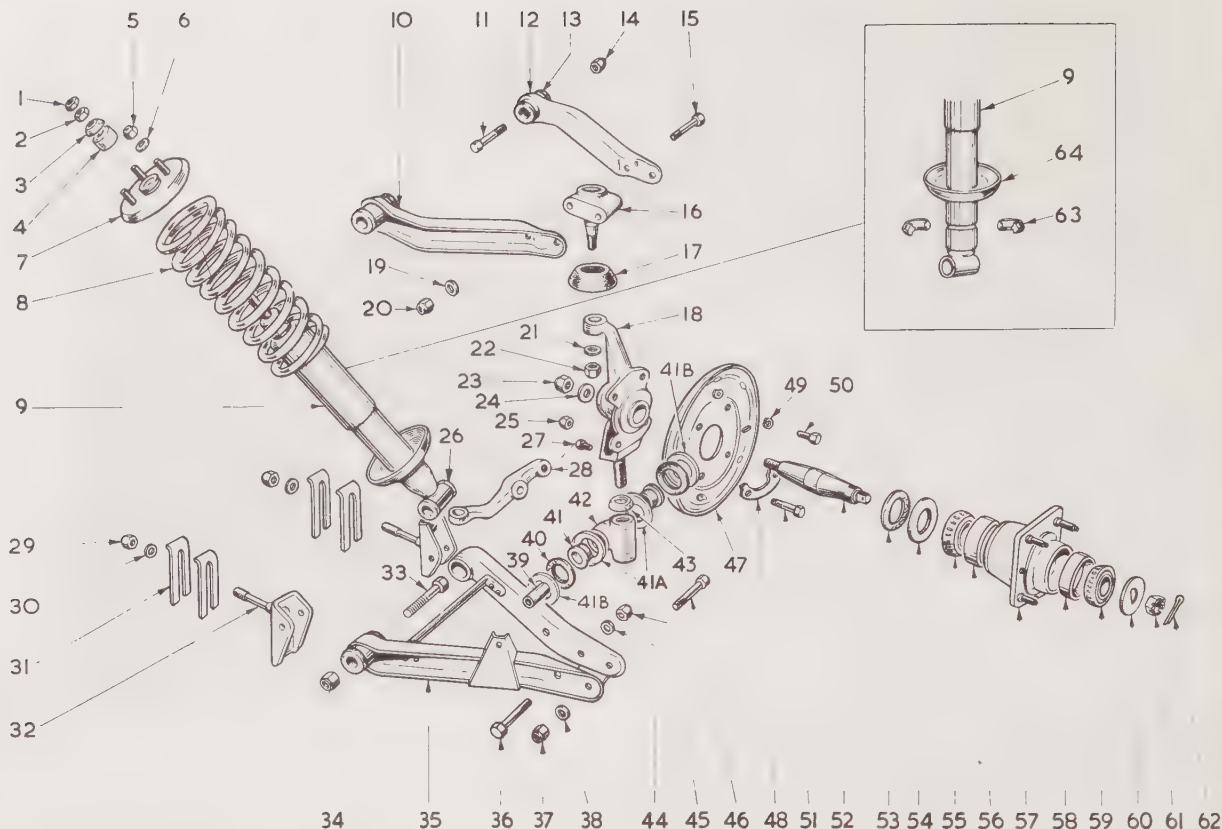


Fig 8:3 Components of front suspension, and hub details.

Key to Fig 8:3 1 Locknut. 2 Nut. 3 Washer. 4 Rubber bush. 5 Nyloc nut. 6 Plain washer. 7 Upper spring pan.
 8 Road spring. 9 Damper. 10 Front upper wishbone arm. 11 Bolt. 12 Rear upper wishbone arm. 13 Rubber bush.
 14 Nyloc nut. 15 Bolt. 16 Ball joint. 17 Rubber gaiter. 18 Vertical link. 19 Plain washer. 20 Nyloc nut. 21 Plain washer.
 22 Nyloc nut. 23 Nyloc nut. 24 Plain Washer. 25 Nyloc nut. 26 Rubber bush. 27 Plug. 28 Steering arm. 29 Nyloc nut.
 30 Plain washer. 31 Shim. 32 Inner fulcrum bracket. 33 Fulcrum bolt. 34 Nyloc nut. 35 Lower wishbone assembly.
 36 Suspension unit fulcrum bolt. 37 Nyloc nut. 38 Plain washer. 39 Steel bush. 40 Rubber seal. 41 Nylon bush. 41A Washer.
 41B Washer. 42 Lower trunnion. 43 Rubber seal. 44 Plain washer. 45 Nyloc nut. 46 Fulcrum bolt. 47 Brake backplate.
 48 Locking plate. 49 Spring washer. 50 Setscrew. 51 Bolt. 52 Stub axle. 53 Felt seal. 54 Seal retainer.
 55 Taper roller bearing—inner. 56 Roller bearing outer ring. 57 Hub. 58 Roller bearing outer ring. 59 Taper roller bearing—outer.
 60 'D' washer. 61 Slotted nut. 62 Split-pin. 63 Spring retaining collet. 64 Spring cup.

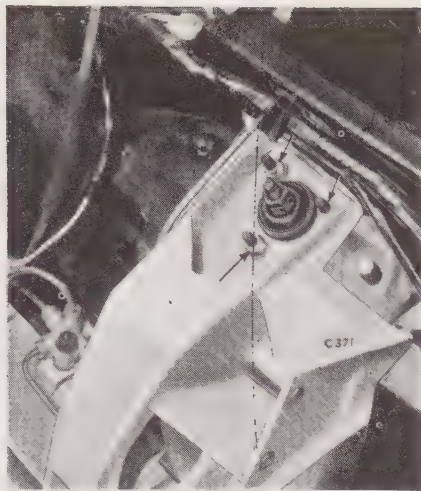


Fig 8:4 Sub-frame of suspension unit. The nuts securing the upper spring pan are arrowed.

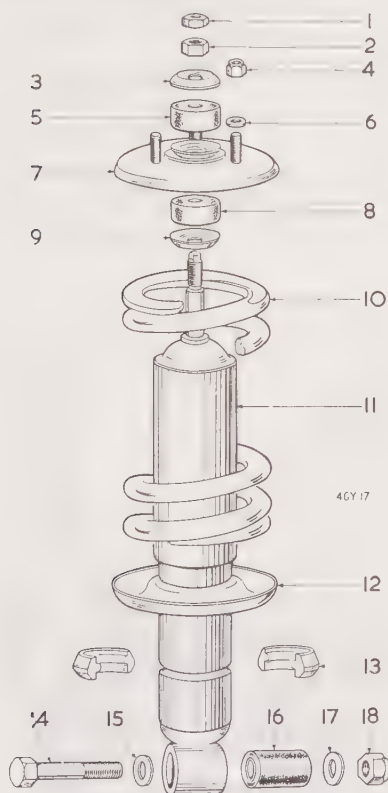


Fig 8:5 Components of spring and shock absorber assembly.

Key to Fig 8:5 1 Locknut. 2 Nut. 3 Washer. 4 Nyloc nut. 5 Rubber bush. 6 Washer. 7 Upper spring pan. 8 Rubber bush. 9 Washer. 10 Road spring. 11 Damper. 12 Lower spring pan. 13 Collets. 14 Bolt. 15 Washer. 16 Metalastik bush. 17 Washer. 18 Nyloc nut.

trunnion, at its attachment to the lower wishbones, must be replaced if worn. The parts must be correctly assembled into the trunnion, the two Nylon bushes being fitted with a washer beneath the flange and with the steel sleeve centrally positioned. The rubber dust excluders are then sprung over the bush flanges, as shown on **FIG 8:10**. Wear in the threaded bearing of the vertical link can only be remedied by replacing the link and trunnion. When reassembling, oil the threaded bore, fit a new rubber seal to the threaded shank (**FIG 8:11**) and screw the shank into the trunnion until it bottoms. Then unscrew it to its working position; that is, so that there is no bottoming on the threads when the steering is at full lock. Note that the parts have a left-hand thread for the left side of the car, and right-hand for the right side. The latter trunnion can be identified as it has a reduced diameter at its lower end for this purpose, as shown on **FIG 8:12**. The trunnion is refitted to the lower wishbone arms as shown on **FIG 8:7**, which also indicates how the various washers are positioned. The nut should finally be tightened to a torque of 42–46 lb/ft.

In regard to the inner pivot points of the wishbones, and other rubber bushed pivots such as the lower attachment of the damper, it is important to note that these must not be finally tightened until the car is resting in its static laden position. This will ensure that the bushes are equally stressed on bump and rebound. When assembling therefore, these articulating points should be tightened finger tight for a start, and pulled up to the specified torque when the car is on its wheels.

When replacing the inner fulcrum brackets on the wishbone arms, take care that the bracket having the longer portion below the centre-line of the attachment stud is fitted to the front wishbone, as shown on **FIG 8:13**. On the rear one, the longer portion is above the stud centre-line. Finally tighten the pivot bolt nuts to a torque of 26–28 lb/ft.

The upper ball joint of the vertical link is replaced as a unit in the event of wear. Reassembly on the vertical link and upper wishbones is generally a reversal of the dismantling operation. The ball joint assembly is inserted

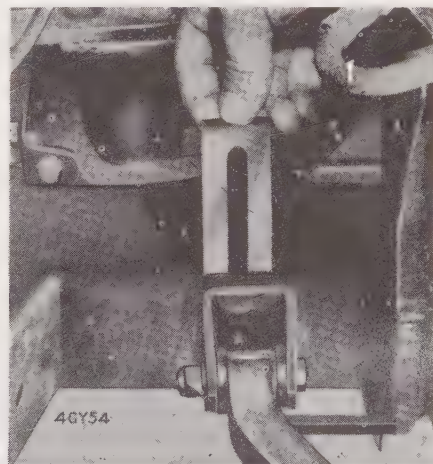


Fig 8:6 The front and rear lower wishbone fulcrum brackets have shims for adjustment as shown here

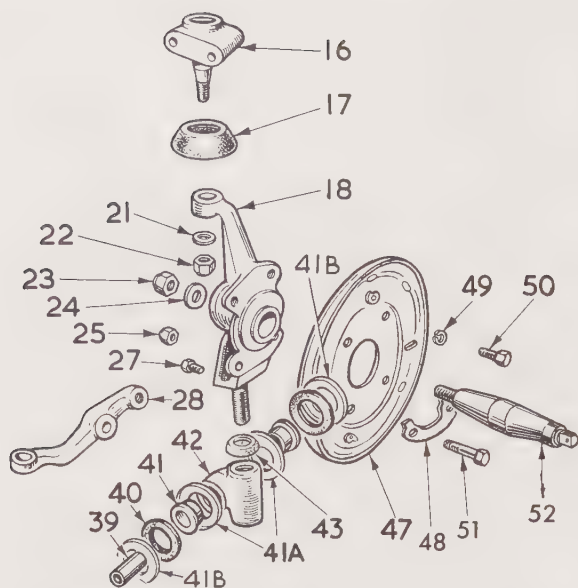


Fig 8:7 Details of vertical swivelling link and associated parts.
(For part numbers refer to Fig 8:3.)

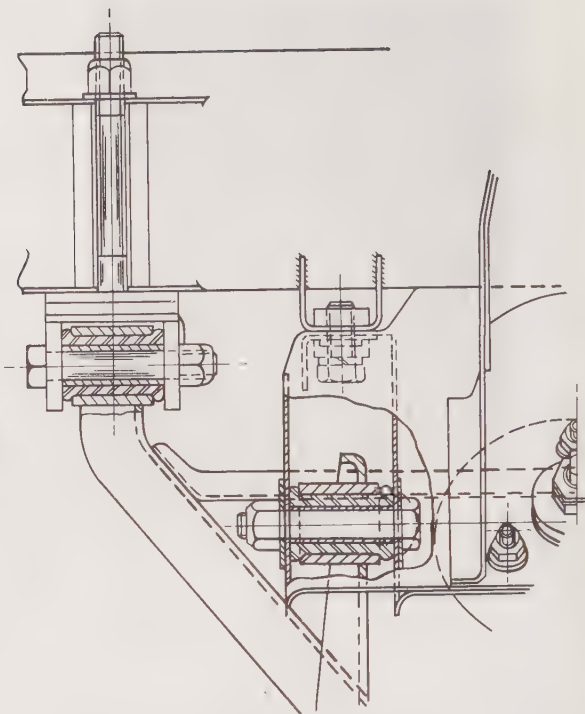


Fig 8:9 Correct positioning of rubber bushes at inner ends of wishbones, with equal protrusion at each side.

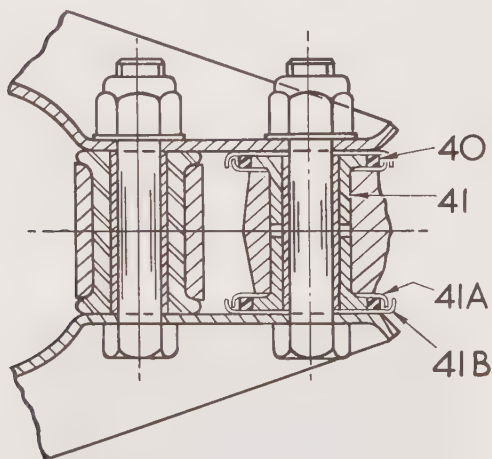


Fig 8:8 Details of lower wishbone attachment to lower trunnion and spring unit.

Key to Fig 8:8 40 Rubber seal. 41 Nylon bush. 41A Inner flanged washer. 41B Outer flanged washer.

between the upper wishbone arms, the bolts fitted and the nuts tightened to 16–18 lb/ft torque. Ensure that the tapered shank of the ball joint and the hole in the vertical link are perfectly clean before fitting, and tighten the nut to a torque of 38–42 lb/ft.

When refitting the fulcrum brackets of the lower wishbones to the chassis note the previous instructions regarding shims. The pivot bolt nuts of the inner wishbones should be finally tightened to 26–28 lb/ft torque. The steering levers and brake components can then be re-



Fig 8:10 Fitting rubber dust excluder to bush flange of lower trunnion.

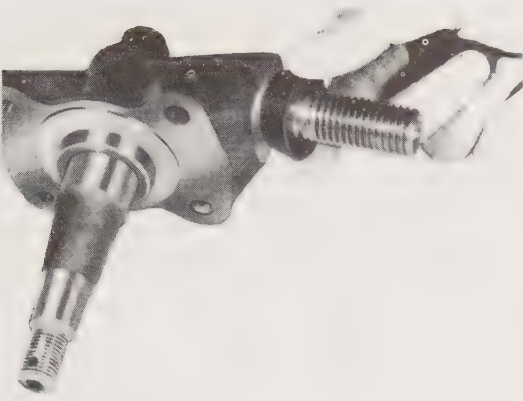


Fig 8:11 Fitting rubber seal at bottom of threaded shank of lower trunnion.

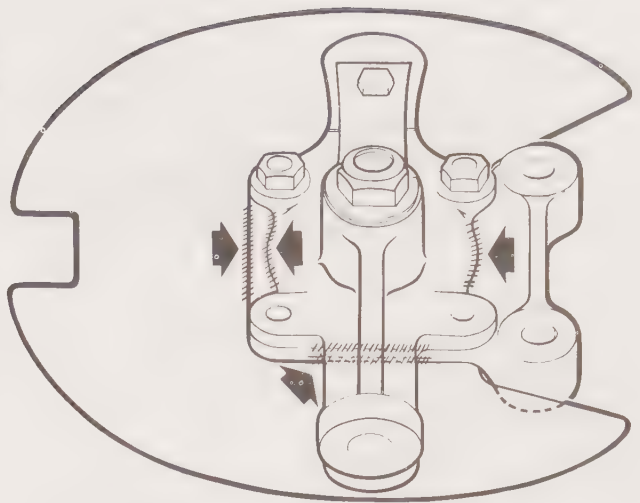


Fig 8:14 Application of sealing compound to brake dust-shield and caliper bracket.



Fig 8:12 Trunnions are identifiable by reduced diameter at lower end on right-hand unit.

Key to Fig 8:12 1 Right-hand. 2 Left-hand.

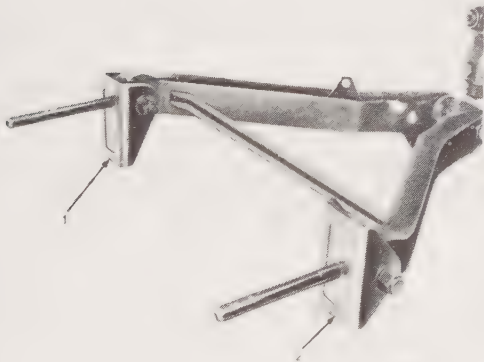


Fig 8:13 The inner fulcrum brackets of lower wishbone have the attachment studs in differing positions.

Key to Fig 8:13 1 Front bracket. 2 Rear bracket.

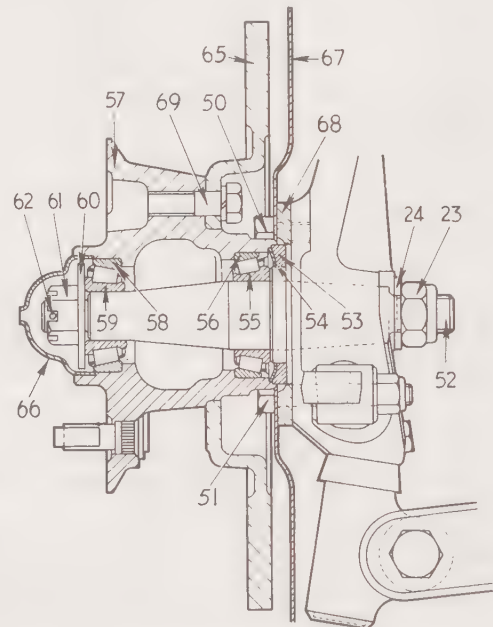


Fig 8:15 Section of front hub and brake. (For part numbers refer to Fig 8:3.)

Additional key to Fig 8:15 65 Brake disc. 66 Hub cap. 67 Dust-shield. 68 Brake caliper bracket.

placed, noting that the dust-shield and caliper bracket should be sealed to the vertical link as shown on **FIG 8:14**, using Expandalite Seal-a-Strip 105S; this is part No. 554420.

After tightening the four nuts and bolts, bend the locking plates carefully to make all secure. The nuts on the tie-rod lever bolts are tightened to 26–28 lb/ft torque and the remainder to 16–18 lb/ft.

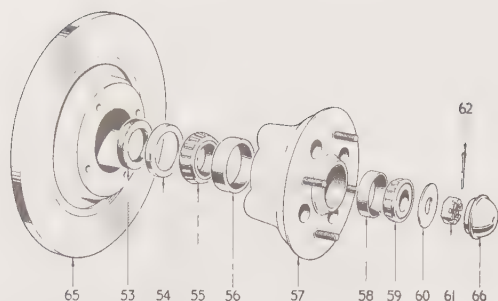


Fig 8:16 Components of hub assembly.

Key to Fig 8:16 53 Felt washer. 54 Seal retainer. 55 Rollers and cage. 56 Outer race. 57 Hub shell. 58 Outer race. 59 Rollers and cage. 60 Washer. 61 Nut. 62 Split-pin. 65 Disc 66 Hub cap.

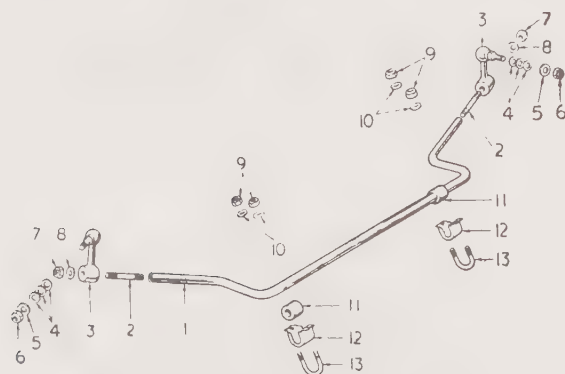


Fig 8:17 Component parts of anti-roll bar.

Key to Fig 8:17 1 Anti-roll bar. 2 Studs. 3 Links. 4 Washers. 5 Washers. 6 Nyloc nuts. 7 Nyloc nuts. 8 Washers. 9 Nyloc nuts. 10 Washers. 11 Rubber bushes. 12 Clamps. 13 'U' bolts.

8:6 Front hubs

The front hubs are of adjustable taper roller bearing type, the design being similar throughout the range. The construction is clear from **FIG 8:15**.

When the hub has been removed from the stub axle as already described, it may be readily dismantled. The outer roller cage with rollers is first removed. Using a soft metal copper drift, the inner roller cage with rollers is then tapped gently out, along with the felt seal (see **FIG 8:16**). The two outer races can then be drifted out of the hub shell.

When all parts have been cleaned, the bearings should be examined. If the races or rollers are pitted or worn, complete replacement of the bearings is necessary. When reassembling, this must first be done with the parts dry and without any lubricant, in order to obtain correct adjustment. The two outer races are first pressed into the hub shell until they are firmly against their registers. Fit the roller races and assemble on to the stub axle, with the washer and slotted end-nut in position. Omit the oil-seal at this stage. Spin the hub, and tighten the nut gradually, until no slackness can be felt. At the same time, do not

permit any binding or tightening-up to an extent which prevents the hub from spinning quite freely. The nut is then slackened back to the nearest split-pin groove. Mark the nut and axle-end so that this position can be obtained later. The hub must now be removed, and the space between the races packed with approved grease, which should also be smeared over the rollers and races. Fit the seal retainer into the hub. Soak the felt seal in oil, squeeze out the surplus oil and locate it in the retainer. The hub may now be refitted to the stub axle in the same manner as before, and the outer nut tightened until the marks coincide to show that it is properly adjusted. Fit a new split-pin, clean the hubcap, put in a small supply of grease, and press the cap home.

When reassembling as above, do not pack the hub shell tightly with grease, but leave a little air space for expansion. This will prevent oil being forced past the seal when the hub warms up in running.

The adjustment detailed is aimed at giving an end-float on the hub of 0.002 to 0.008 in (0.05 to 0.2 mm). If this cannot be obtained by rotating the nut as described, the washer may be faced in addition. The aim is of course to obtain the minimum specified end-float with the nut positioned so that it can be split-pinned.

When adjusting the bearings as a routine maintenance operation, the road-wheel is removed and the end-float tested. If this exceeds 0.008 in (0.2 mm) remove the split-pin and tighten the nut until the correct end-float is obtained. Make sure at all times that the split-pin is in new condition.

8:7 Anti-roll bar

The anti-roll bar is shown in detail on **FIG 8:17**. It is carried on the front end of the chassis in two rubber bushes held by clamps and U-bolts, and is linked to the lower wishbones by ball-and-socket attachments. To remove the bar, the nuts are unscrewed from the U-bolts and the clamps released. The links can be detached from the wishbones by taking off the nuts as already detailed. If any rubber bushes require renewal, the links may also be taken off the bar ends by unscrewing the end-nuts, leaving the bar completely free. To replace the bar, it should first be attached to the chassis by the U-bolts and clamps, the wishbone links then being fitted. Note that as in the case of the other rubber-bushed suspension points, the nuts must be tightened with the car in its static laden condition.

Always ensure that the various Nyloc stiff-nuts used throughout the suspension are in good condition and tight on their threads before refitting. This type of nut will withstand several removals, and is designed for removal and replacement, but in some cases the gripping power of the insert may deteriorate after much use.

8:8 Fault diagnosis

(a) Wheel wobble

- 1 Worn hub bearings
- 2 Broken or weak front springs
- 3 Uneven tyre wear
- 4 Worn suspension linkage
- 5 Loose wheel fixings

(b) 'Bottoming' of suspension

- 1 Check 2 in (a)
- 2 Dampers defective

(c) Heavy steering

- 1 Neglected lubrication
- 2 Inaccurate suspension geometry

(d) Excessive tyre wear

- 1 Check 4 in (a); 3 in (b); and 2 in (c)

(e) Rattles

- 1 Check 2 in (a)
- 2 Lubrication neglected, bushes worn
- 3 Damper mountings loose
- 4 Anti-roll bar mountings loose, bushes worn

(f) Excessive 'rolling'

- 1 Check 2 in (a); and 3 in (b)
- 2 Anti-roll bar broken, mountings loose, bushes worn

CHAPTER 9

THE STEERING GEAR

- 9:1 Dismantling
- 9:2 Overhaul
- 9:3 Tie-rods
- 9:4 Ball joints
- 9:5 Replacement of steering box

- 9:6 Steering column
- 9:7 Bearing bushes
- 9:8 Reassembly
- 9:9 Steering adjustments
- 9:10 Fault diagnosis

The steering gear is of the rack and pinion type, having two track rods of equal length, which connect the ends of the rack to the steering levers on the vertical swivelling links of the suspension. The splined pinion shaft from the rack box is secured by a pinch-bolt to the boss of a flexible coupling at the lower end of the steering column-shaft.

The arrangement of the mechanism differs in minor details only as between the various cars.

9:1 Dismantling

The steering unit is shown dismantled on **FIG 9:1**. To remove the rack box the car must first be supported at the front on stands, and the road wheels removed. The pinchbolt and nut is next unscrewed from the lower half of the steering shaft coupling. The steering tie-rod ends are uncoupled from the steering arms on the vertical links, using a Churchill or similar press-tool as described in Chapter 8.

The rack box is secured to the car frame by two 'U' bolts in conjunction with packing pieces (**FIG 9:2**). After removing the nuts from the 'U' bolts, the rack box can be moved forwards, which will pull the pinion shaft clear of the splined coupling. The box on the 'Spitfire' can then be taken from the car, but on 6-cylinder types it is necessary to remove the bolts from the front engine mountings and raise the front of the engine about 0.75 in so as to give room for withdrawal. A suitable sling

or hoist is required to take the engine weight when removing the mounting bolts, and again when lifting to the required amount. There is an aperture in the right-hand side valance to facilitate withdrawal of the box.

At each end of the rack box is a rubber gaiter, which is released by slackening the retaining clip; this allows the gaiter to be pulled from the rack box and slid towards the end of the tie-rod. The tie-rods are detached from the rack-ends by slackening the locknuts and unscrewing each tie-rod assembly from the rack. Remove the coil springs from the ends of the rack. To dismantle the tie-rod assembly, unlock the tabwasher and remove the sleeve nut, tabwasher and thrust pad. Then slacken the locknuts at the outer ball-joints and unscrew the joint. Remove the locknut completely, and this will allow the gaiter, clips, and cup-nut of the inner joint to be taken off the tie-rod.

To dismantle the rack box, remove the locknuts from each end of the rack. Unscrew the cap nut, which incorporates an oil filler plug, located above the pinion, and take out the shim pack, coil spring and pressure pad. Withdraw the pinion assembly (**FIG 9:3**) by removing the circlip, taking care not to lose the small dowel. Take out the retaining ring, shims, bush, and thrust washer in that order, and also the rubber 'O' ring from its annular groove in the retaining ring.

The rack can then be withdrawn from the rack box. Finally, remove the thrust washer and bush supporting the blind end of the pinion shaft, from the housing.

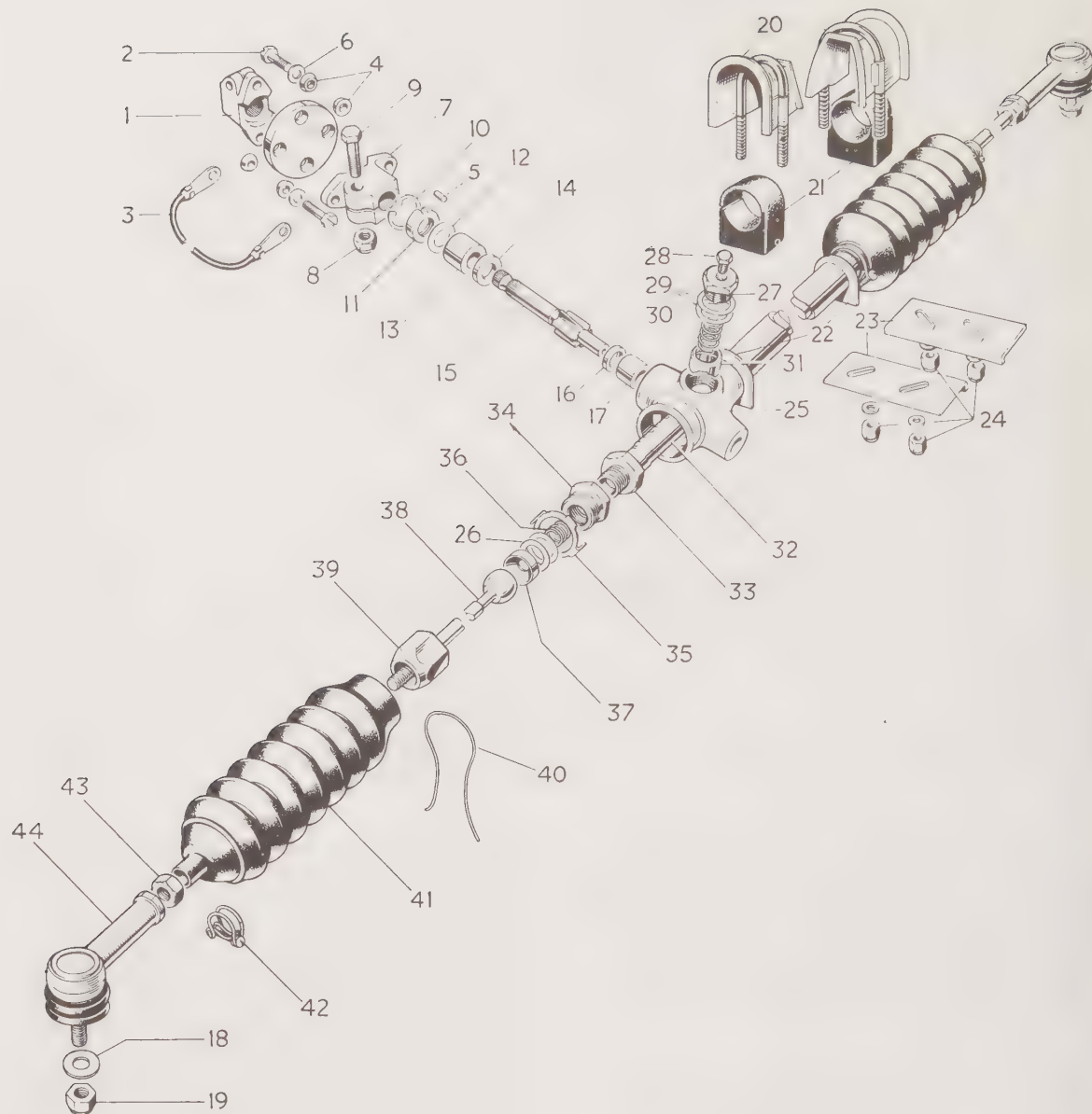


Fig 9:1 Components of steering gearbox and track-rod.

Key to Fig 9:1 1 Steering coupling—upper. 2 Bolt. 3 Earth cable. 4 Rubber bushes. 5 Dowel. 6 Washer. 7 Steering coupling—lower. 8 Nyloc nut. 9 Pinch bolt. 10 Circlip. 11 Retaining ring. 12 Shims. 13 Bush. 14 Thrust washer. 15 Pinion shaft. 16 Thrust washer. 17 Bush. 18 Washer. 19 Nyloc nut. 20 'U' bolts. 21 Rubber bushes. 22 Abutment plates. 23 Locating plates. 24 Nyloc nuts. 25 Rack assembly. 26 Shims. 27 Cap. 28 Grease plug. 29 Shims. 30 Spring. 31 Plunger. 32 Rack. 33 Locknut. 34 Sleeve nut. 35 Lock tab. 36 Spring. 37 Cup. 38 Tie-rod. 39 Cup nut. 40 Locking wire. 41 Rubber gaiter. 42 Clip. 43 Locknut. 44 Tie-rod end.

9:2 Overhaul

After all components have been thoroughly cleaned, the bushes at the end of the rack box should be examined. These can be renewed if worn, this being done by a Triumph agent. The rack and pinion wear very slowly, and need only be replaced when backlash becomes excessive. This also applies to the thrust washers and bushes of the pinion shaft. If any components of the tie-rod ball joint assemblies show signs of wear or damage, these must also be replaced; the tie-rods must also be perfectly straight.

To reassemble the mechanism, first fit the bush and thrust washer into the pinion housing. Next insert the rack and assemble the thrust washer, bush and retaining ring on to the pinion shaft; refer to **FIG 9:3** for clarity. Secure the components with the circlip, and mount a dial gauge suitably, so that the end-float on the pinion shaft can be checked. Push the shaft fully downwards and zero the gauge. Lift the shaft until the retaining ring is fully up against the circlip, and read the gauge, this figure being the maximum shaft float. Now remove the circlip and take out the shaft assembly. Renew the 'O' ring in the retaining ring. Make up a shim pack to a little less thickness than the end-float reading, so as to give minimum float consistent with free rotation of the shaft. The shim thicknesses available are 0.004 and 0.010 in. Fit the shim pack on the shaft between the bush and retaining ring. Refit the remaining components and check for free rotation.

The pressure pad is shown in detail on **FIG 9:4**. This should now be fitted minus its spring, and the cap nut screwed down until there is no end-float on the pad. Insert a feeler gauge between the underside of the nut hexagon and the housing face (**FIG 9:5**) and measure the clearance.

Make up a shim pack of a thickness equal to the feeler gauge measurement plus 0.0004 in (0.1 mm). Remove the nut, fit the shim pack to its threaded shank, insert the spring into the housing and fit the nut and shim pack, screwing down firmly. With correct adjustment, a force of 2 lb at a radius of 7.9 in should be required to rotate the pinion shaft.

9:3 Tie-rods

Assembly of the tie-rods to the rack ends is quite straightforward. The locknuts are first fitted to the rack. On each tie-rod the cup-nut is smeared with grease and fitted, followed by the gaiter with the clips in position, and the locknuts for the outer ball-joints. The ball-joints are then screwed on to the tie-rods to the position shown on **FIG 9:6** and the locknuts tightened.

Each inner ball joint is next fitted with a greased thrust pad and a new tabwasher. Replace the sleeve nut and tighten it. The lockwasher should then have its alternate tabs bent over to lock both the sleeve nut and the cup nut. Insert the coil spring into the rack-end, and screw the ball-joint assembly on to the rack-end.

Pack about $\frac{1}{4}$ ounce of grease into each gaiter, spreading it evenly.

The inner end of the gaiter can then be pulled on to the rack box and clipped into place. The outer clips should also be tightened.

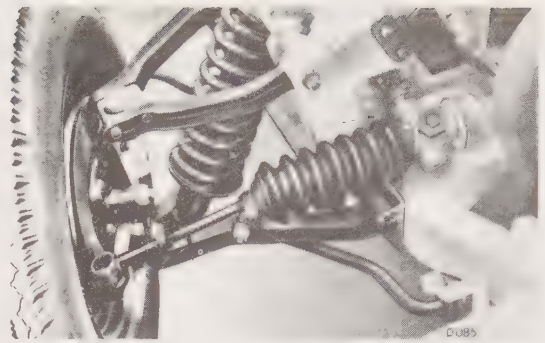


Fig 9:2 Pinion end of rack housing, showing U-bolts to chassis, steering shaft coupling, and track-rod details.

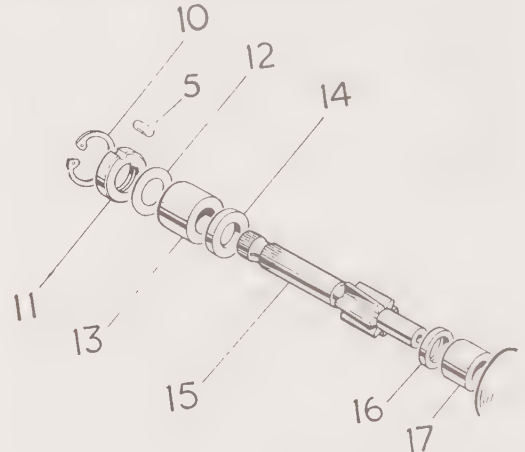


Fig 9:3 Components of pinion assembly.

Key to Fig 9:3 5 Dowel. 10 Circlip. 11 Retaining ring. 12 Shims. 13 Bush. 14 Thrust washer. 15 Pinion shaft. 16 Thrust washer. 17 Bush.

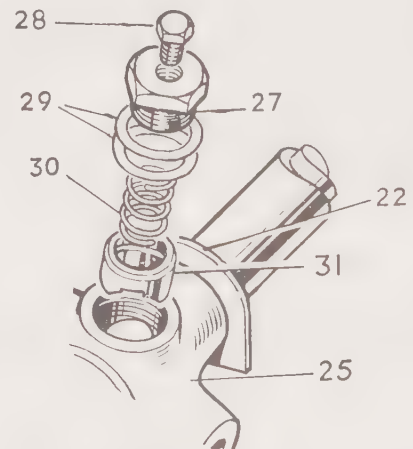


Fig 9:4 Components of thrust pad assembly.

Key to Fig 9:4 22 Abutment plate. 25 Rack housing. 27 Cap. 28 Filler plug. 29 Shims. 30 Spring. 31 Plunger.



Fig 9:5 Clearance measurement when assembling pressure-pad, as explained in text.

9:4 Ball joints

To adjust the inner ball-joints of the tie-rods (FIG 9:7) the joint is first assembled as already described, and the sleeve nut screwed firmly into the cup-nut containing the ball-end of the tie-rod. The sleeve nut is now clamped in a vice, and the tie-rod moved axially, so as to articulate the ball-joint and determine approximately the thickness of shim pack required. Dismantle the joint, and add shims to the pack in excess of the number required. Assemble the joint again, with the sleeve nut screwed home. Due to the shim thickness, there will be a gap between the sleeve nut flange, locking tab and face of the cup nut. This dimension, plus 0.002 in (0.05 mm), is the amount by which the shim pack has to be reduced so as to give the correct working movement for the ball. Having determined the shim thickness in this manner, dismantle the joint, and reassemble with the correct shim pack. If all is well, the end of the tie-rod should articulate freely when a side load of 1.5 lb (0.681 kg) is applied at the outer end of the rod. The shim pack must be adjusted to give this condition, shims being obtainable in thicknesses of 0.002 and 0.010 in (0.05 and 0.254 mm). The cup nut and sleeve nut must finally be locked, by bending over the tab-washer.

When refitting the ball-joints to the rack-ends, the lock-nuts on the rack should be positioned to give the dimensions shown on FIG 9:6. It will be noted that the dimension between the inner faces of the two locknuts is 24.4 in (619.76 mm). The locknuts and outer joints of the tie-rods are then replaced on the rods, and adjusted to correspond with the dimensions shown on FIG 9:6.

9:5 Replacement of steering box

Before replacing the steering box on the car, refer to FIG 9:6, and check that the box has been assembled to the dimensions stated. Next rotate the pinion shaft for

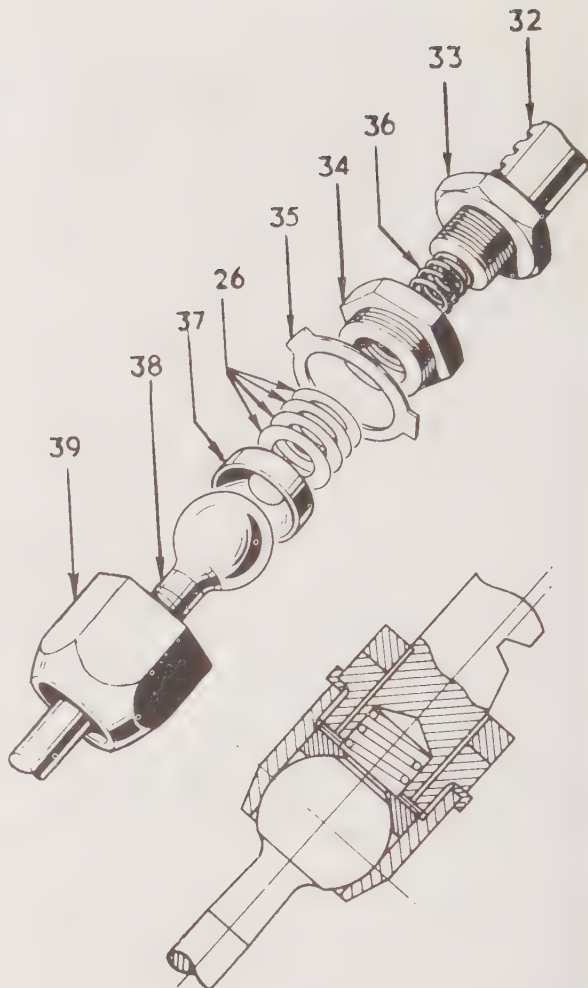


Fig 9:7 Components of shim-adjusted inner ball joint.

Key to Fig 9:7 32 Rack end. 33 Locknut. 34 Sleeve nut. 35 Lock washer. 36 Spring. 37 Cup. 38 Ball-ended tie-rod 39 Cup nut.

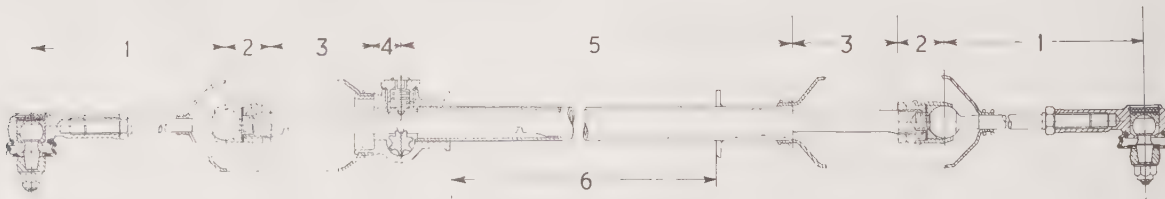


Fig 9:6 Correct dimensions for steering tie-rod assembly.

Key to Fig 9:6 1 8.715 in (221.36 mm). 2 1.42 in (36.07 mm). 3 3.325 in (84.45 mm). 4 0.875 in (22.23 mm). 5 16.875 in. 6 12.78 in (324.62 mm).

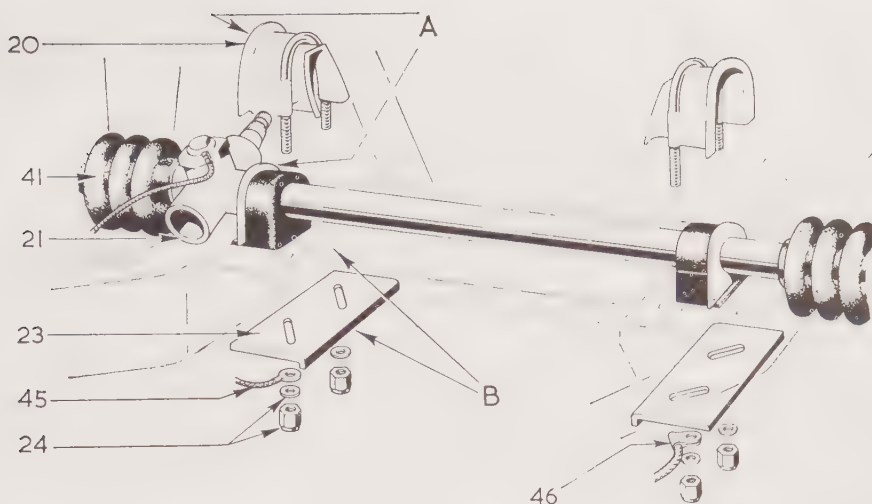


Fig 9:8 Mounting of rack housing on chassis.

Key to Fig 9:8 20 'U' bolt. 21 Rubber bush. 23 Locating plates. 24 Nuts. 41 Rubber gaiter. 45 Earthing cables
46 Earthing cable (engine). Dimension A (between flanges) 0.125 in. (3.1 / mm). Item B Flange 23 must contact innermost flange of frame.

the complete rack travel from lock to lock, and count the number of revolutions. From one lock, rotate the shaft through half this number of turns, which will centralise the rack in relation to the pinion.

The steering wheel is next positioned in the straight-ahead position. Its precise positioning should be familiarised before dismantling. The steering unit is then repositioned in the car, being introduced through the valance opening. On six-cylinder cars, the engine will require raising at the front, as was done when removing the steering unit.

The flexible coupling should next be engaged to connect the pinion shaft to the steering column shaft in the correct relative positions. The rubber bushes shown on **FIG 9:8** are next fitted to the rack box, the 'U' bolts assembled, and loosely secured by means of the under-plates and nuts. The 'U' bolt assemblies are then pushed outwards until there is $\frac{1}{8}$ in (3.175 mm) clearance between the two flange plates which are welded to the rack box, and the retainers on the 'U' bolts. (**FIG 9:8** will make all clear.) The 'U' bolts should now be held in this position, while a helper slides the under-plates inwards so that their down-turned flanges abut firmly against the chassis frame flanges. The 'U' bolt nuts in all cases, are tightened to a torque of 14–16 lb/ft. Take care also that any earthing straps are replaced under the nuts. The steering coupling bolt and nut is next fitted and tightened. Refit the taper pins of the outer ball-joints to the steering levers, and tighten the nuts to 26–28 lb/ft torque.

9:6 Steering column

The components of the steering column are shown on **FIG 9:9**. The assembly is carried in upper and lower clamps attached to the car body, and is designed to telescope on impact. To remove the column from the car, the

bolt is first withdrawn from the pinion shaft coupling, and the various electric cables disconnected at their snap connectors. Take a note of the colour-code of the cables to aid in reconnecting. The lower portions of the upper and lower column clamps can then be taken off, and the column completely withdrawn from the car (**FIG 9:10**).

To dismantle the column, first spring off the cable clip, then prise the horn push assembly from the steering wheel boss and take out the contact bush (refer to **FIG 9:9** for details). Take off the switch covers by removing their two retaining screws, and detach the switches. Unscrew the bolts of the impact clamp and remove the two parts of the clamp (**FIG 9:11**). The lower part of the column shaft which forms part of the telescoping assembly can now be withdrawn downwards; the upper part of the shaft is withdrawn upwards, along with the steering wheel. To take off the steering wheel, the upper shaft should be clamped in a vice with smooth jaws, and the top nut, spring clip and horn contact removed. The steering wheel can then be withdrawn from its taper by means of an extractor, the standard type being Churchill tool No. S3600.

9:7 Bearing bushes

To remove the rubber bearing bushes from the column-tube, first take off the lower end-cap. The bushes are located by moulded protrusions which register with holes drilled in the column as shown on **FIG 9:12**. These protrusions must be depressed to clear the holes, after which the bushes can be pushed out by using a bar inside the tube. The metal inserts and Nylon bushes can then be removed from the rubber bushes.

The steering column bushes must be in good and shake-free condition, and the various switches should operate correctly; otherwise there are no components liable to wear or give trouble. To reassemble the column, the rubber bushes are first fitted with their Nylon bushes and

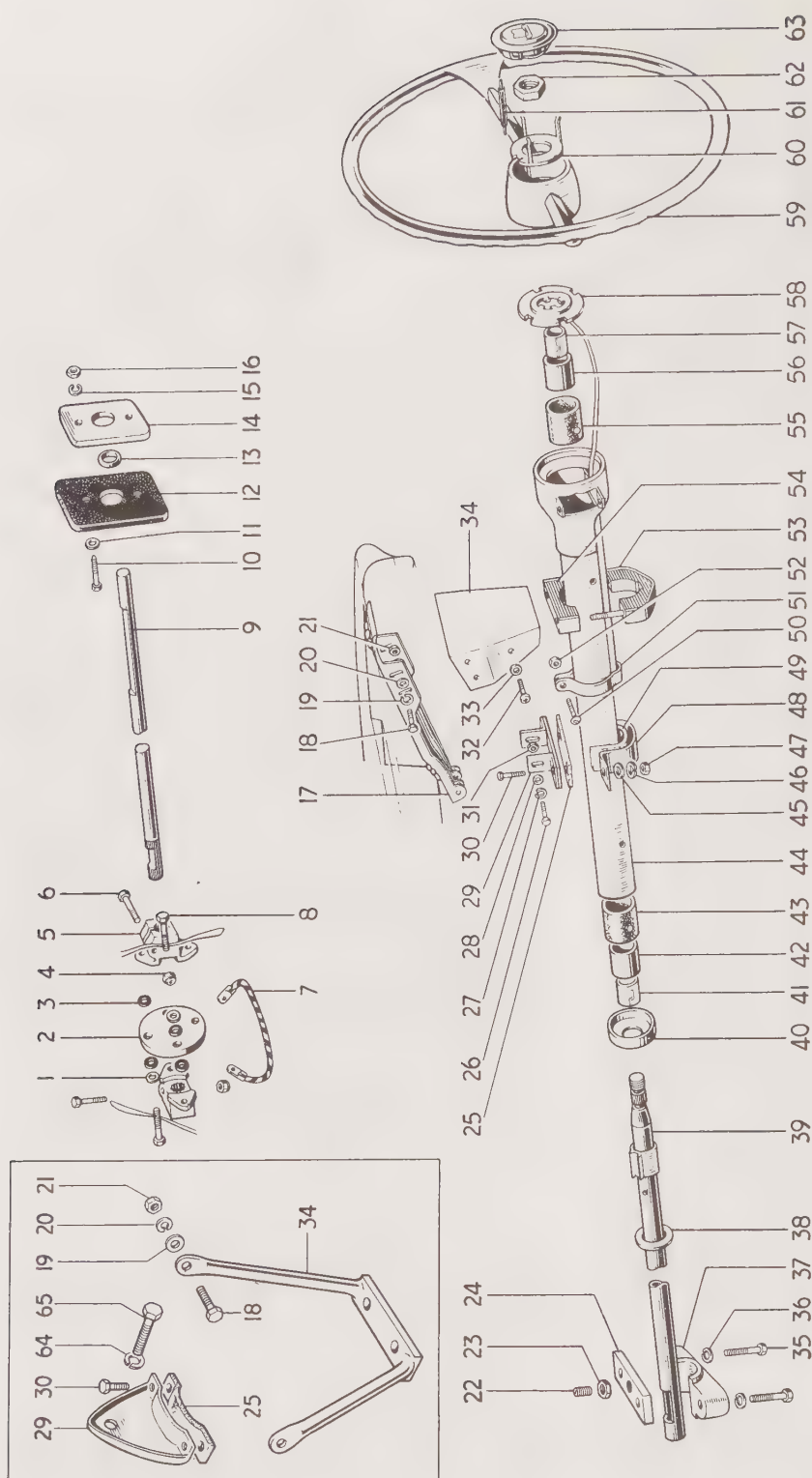


Fig 9:9 Components of steering column. Alternative type of clamp is shown inset.

Key to Fig 9:9 1 Washer, 2 Disc, 3 Rubber washer, 4 Nyloc nut, 5 Adaptor, 6 Pinch bolt, 7 Earth cable, 8 Bolt, 9 Lower steering column, 10 Bolt, 11 Washer, 12 Rubber seal, 13 Washer, 14 Retaining plate, 15 Spring washer, 16 Nut, 17 Supporting bracket, 18 Bolt, 19 Spring washer, 20 Washer, 21 Nut, 22 Socket screw, 23 Nut, 24 Clamp plate, 25 Felt pad, 26 Bolt, 27 Spring washer, 28 Washer, 29 Bracket, 30 Bolt, 31 Nut, 32 Screw, 33 Washer, 34 Bracket, 35 Bolt, 36 Spring washer, 37 Clamp, 38 Nylon washer, 39 Upper inner steering column, 40 End cap, 41 Nylon bush, 42 Steel bush, 43 Rubber bush, 44 Outer upper column, 45 Washer, 46 Spring washer, 47 Nut, 48 Lower outer column clamp, 49 Felt pad, 50 Screw, 51 Cable trough clip, 52 Nut, 53 Upper clamp (lower half), 54 Upper clamp (upper half), 55 Rubber bush, 56 Steel bush, 57 Nylon bush, 58 Horn contact ring, 59 Steering wheel, 60 Clip, 61 Horn contact brush, 62 Nut, 63 Horn push, 64 Spring washer, 65 Bolt.

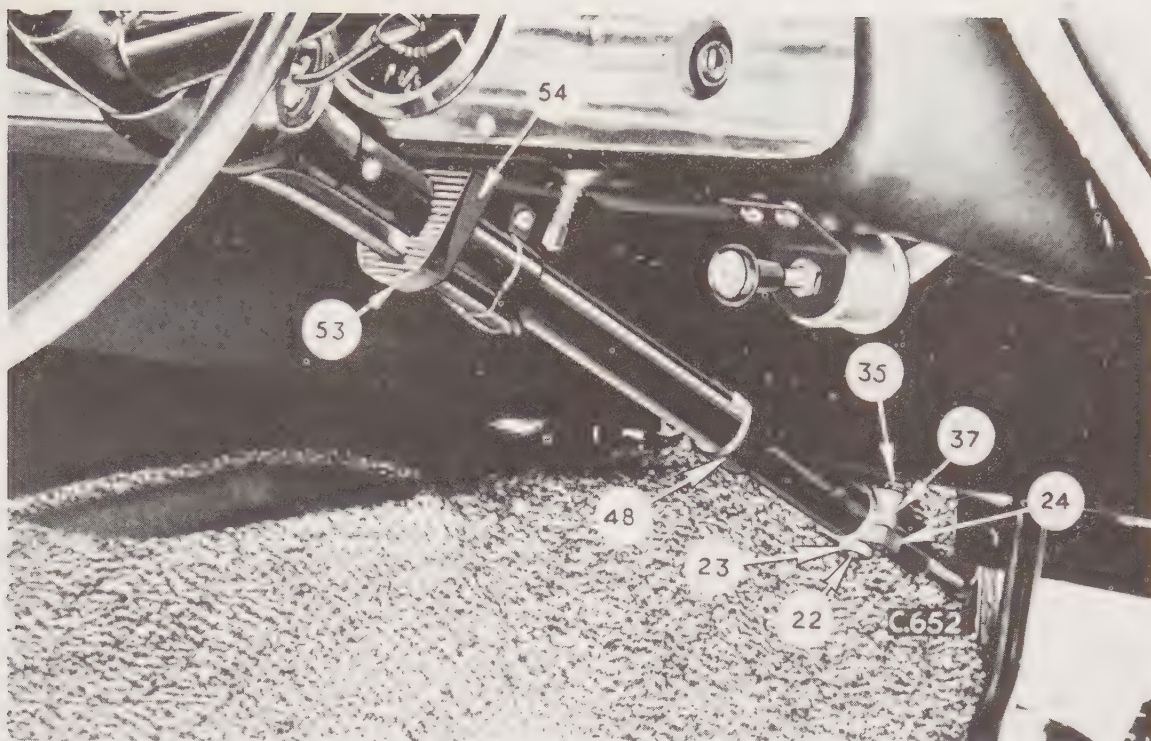


Fig 9:10 Attachments of steering column and impact clamp.

Key to Fig 9:10 22 Clamp socket-screw. 23 Locknut. 24 Clamp plate. 35 Bolt. 37 Clamp. 48 Lower column attachment. 53 Upper column attachment.

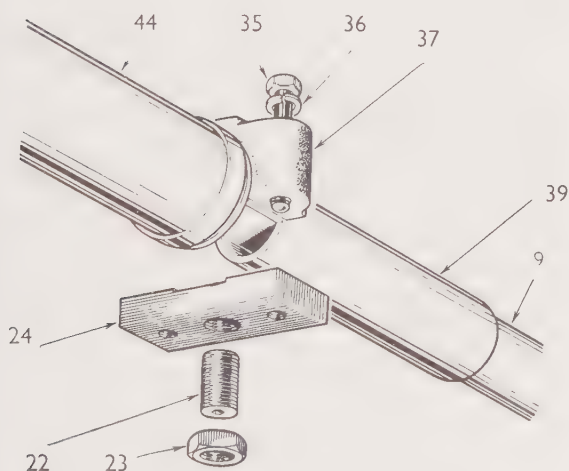


Fig 9:11 Details of impact clamp.

Key to Fig 9:11 9 Lower column-shaft. 22 Socket screw. 23 Locknut. 24 Clamp plate. 35 Bolt. 36 Washer. 37 Clamp. 44 Upper column tube.

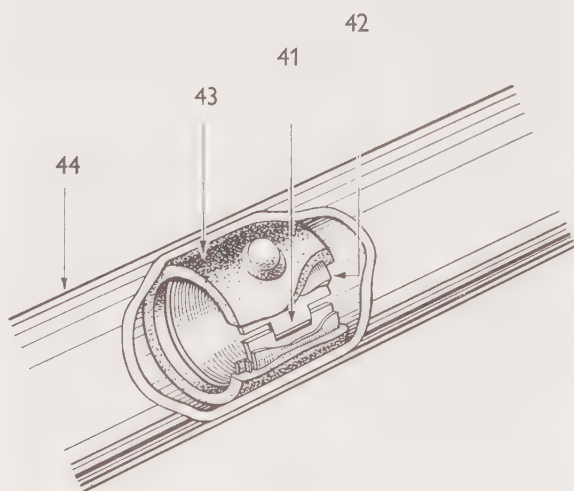


Fig 9:12 Bearing bush in upper column tube.

Key to Fig 9:12 41 Nylon bush. 42 Steel bush. 43 Rubber bush. 44 Column tube.

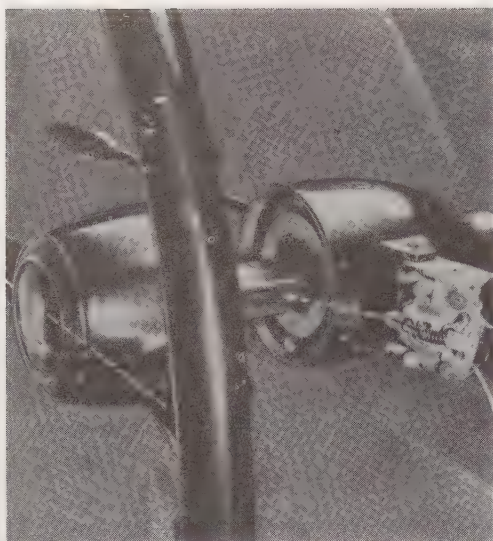


Fig 9:13 Positioning of steering wheel and cancelling lugs relative to direction-indicator switch.

steel sleeves, and the assembly pushed down the column tube, until the protruding rubber lugs engage in their holes in the tube (**FIG 9:12**). It is important that the metal ring at the end of the rubber bush, seen on the left of the bush, is positioned at the lower end.

Note that on the upper steering column shaft there is a clip integral with two parallel direction-indicator cancelling lugs. When replacing the steering wheel on the shaft, these must lie under the spoke in the straight-ahead position, as shown on **FIG 9:13**. Fit the wheel, also the horn contact ring and clip, and secure with the top nut. The top of the shaft may be lightly peened to prevent unscrewing.

If the direction-indicator switch requires replacement, a new cancelling-clip and setscrew must also be used.

9:8 Reassembly

The impact clamp bolts are next tightened fully. Referring to **FIG 9:11**, tighten the clamp grub screw with a socket key, to as great an extent as possible, using hand force without bending the key. Then tighten its locknut.

It will be appreciated that the purpose of the safety clamp is to allow the two concentric steering-column shafts to telescope under impact, while at the same time the column tube is pushed downwards in its upper and lower clamps. If however the column is adjusted to suit the driver so that it is in its lowest position, no telescoping action will be available.

9:9 Steering adjustments

There should be a toe-in of zero to $\frac{1}{8}$ in on the front wheels when stationary, to ensure parallel tracking under load. This should always be measured by the correct type of gauge available to agents, makeshift methods being useless. The toe-in is adjusted by slackening the locknuts at the outer ball-joints on the tie-rods and rotating the rods so as to screw in or out of the ball-joint assembly. The locknuts are then tightened.

Should any difficulty be experienced with the steering when all the components have been confirmed as in good condition in line with the foregoing the car should be taken to an agent for a complete check of all steering angles. This has now become a scientific process, calling for much specialized equipment, but this is necessary because of the critical nature of these dimensions, in relation to good handling of the car.

9:10 Fault diagnosis

(a) Wheel wobble

- 1 Unbalanced wheels and tyres
- 2 Slack steering connections
- 3 Incorrect steering geometry
- 4 Excessive play in steering gear
- 5 Broken or weak front springs
- 6 Worn hub bearings

(b) Wander

- 1 Check 2, 3 and 4 in (a)
- 2 Front suspension and rear axle mounting points out of line
- 3 Uneven tyre pressures
- 4 Uneven tyre wear
- 5 Weak dampers or springs

(c) Heavy steering

- 1 Check 3 in (a)
- 2 Very low tyre pressures
- 3 Neglected lubrication
- 4 Wheels out of track
- 5 Steering gearbox incorrectly adjusted
- 6 Steering columns bent or misaligned
- 7 Steering column bearings too tight

(d) Lost motion

- 1 End play in steering column
- 2 Loose steering wheel, worn splines
- 3 Worn steering box
- 4 Worn ball joints
- 5 Worn suspension system and swivels

CHAPTER 10

THE BRAKING SYSTEM

10:1 Brake adjustment
10:2 Rear brake overhaul
10:3 Brake cylinders
10:4 Front brake overhaul
10:5 Brake discs

10:6 Brake bleeding
10:7 Vacuum servo unit
10:8 Handbrake
10:9 Fault diagnosis

The braking system is of the hydraulic type, using drum brakes on the rear wheels, and disc brakes at the front.

Operation is by a pedal assembly and master cylinder, this being identical with that used for the clutch and described in Chapter 5, except that in some cases a larger fluid reservoir is employed.

From the master cylinder delivery union, a metal pipe feeds the fluid to a four-way connector, two of whose outlets connect to the left- and right-hand front brake pipes. A third outlet is coupled to a pipe which leads to a three-way connector at the rear of the car, this incorporating a pressure-switch for operation of the stop lights. Two outlets from this connector are coupled to the rear brake pipes.

The rigid pipe system is connected at its four terminations, to flexible hoses coupled to the brake actuating cylinders.

A typical pipeline layout is shown on **FIG 10:1**. Trouble with the rigid part of the piping is most improbable except as a result of damage. It is, however, important periodically to check the flexible hoses and unions for any sign of leakage or deterioration. Chafing, perishing or other faults must be remedied by replacement; in particular leakage is dangerous, and at the first sign the pipe system must be examined. Blocked hoses cannot be probed clear with safety, and should be renewed. To avoid damage when uncoupling the flexible connections, the correct procedure is first to unscrew the union nut on the steel pipe from its connection to the hose-end. Then hold the union on the hose with a spanner, and take off the locknut which secures the flexible hose to the

frame bracket. The hose will then be free to rotate, and can be unscrewed from the brake cylinder union by means of the hexagon at that end. When refitting, the latter end must be coupled and tightened first, to avoid twisting the hose. The opposite end is then located in the bracket, and the union held by one spanner while the locknut is tightened with another. The steel pipe is then connected up.

Whenever the pipeline is disturbed in any way, the brakes will require bleeding, as described later. The master cylinder is removed and dismantled in the same manner as described for the clutch operating cylinder in Chapter 5, the components being shown on **FIG 10:2**.

10:1 Brake adjustment

Each rear brake assembly has its own individual 'clicker' type adjusting device, as shown on **FIG 10:3**. The procedure for adjustment is to jack up the wheels clear of the ground, and apply the footbrake hard so as to centralize the shoes in the drum. Spin the wheel and turn the adjuster clockwise until the shoes are locked against the drum; then slacken the adjuster by two 'clicks', when the wheel should turn freely. If difficulty is experienced in obtaining free running with two 'clicks' retraction of the adjuster, ascertain if one or two heavy pressures on the pedal make any difference (i.e. brake the wheel while it is spinning with the help of an assistant). The trouble may be due to minor highspots on the lining, or a small amount of foreign matter in the drum. When linings have been

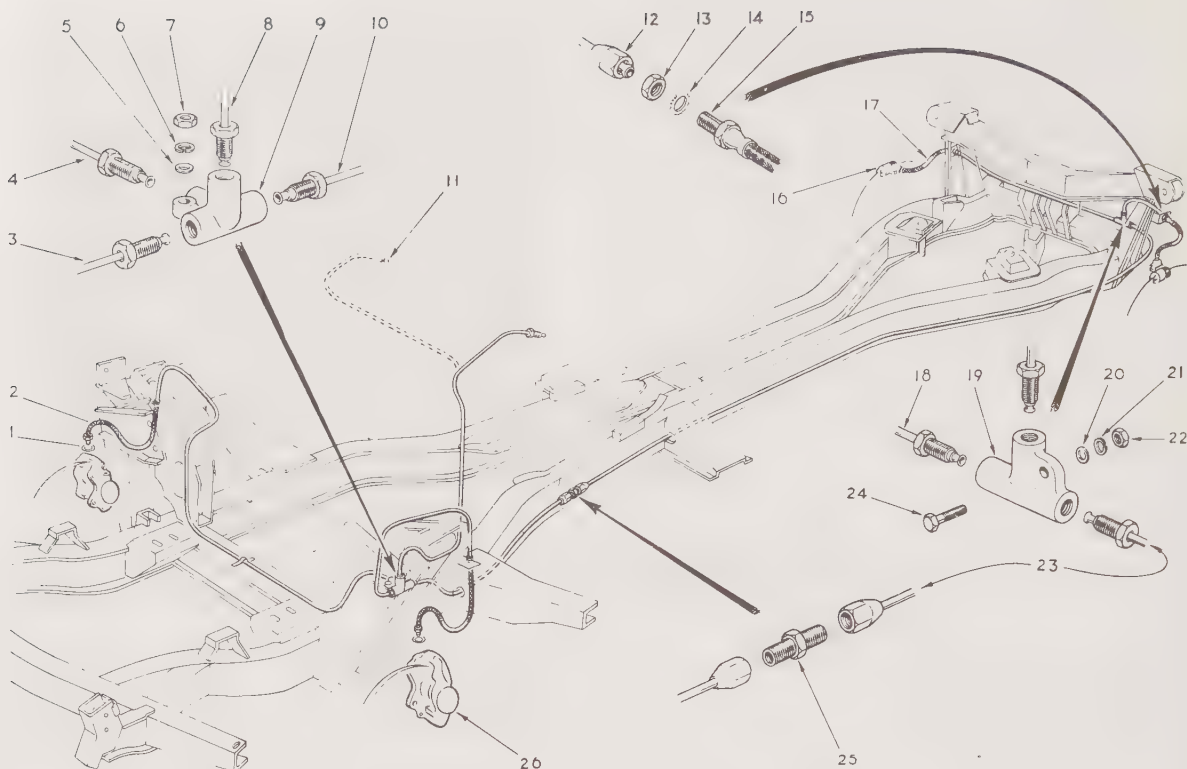


Fig 10:1 Typical layout of hydraulic pipelines ('Spitfire')

Key to Fig 10:1 1 Copper washer. 2 Flexible hose. 3 Pipe—4-way union to LH front brake. 4 Pipe—4-way union to RH front brake. 5 Plain washer. 6 Spring washer. 7 Nut. 8 Pipe—4-way union to master cylinder. 9 4-way union. 10 Pipe—4-way union to rear brakes. 11 Pipe—4-way union to master cylinder (RH drive). 12 Pipe union to flexible hose. 13 Nut. 14 Shakeproof washer. 15 Flexible hose—threaded end. 16 Rear wheel cylinder. 17 Flexible hose—rear brakes. 18 Pipe—3-way union to RH rear brake. 19 3-way union. 20 Plain washer. 21 Spring washer. 22 Nut. 23 Pipe—master cylinder to 3-way union. 24 Bolt. 25 Pipe connector. 26 Front brake caliper unit.

renewed, it is possible that a three-click back-off will be necessary to restore freedom, but it should be possible to restore this to normal after a short period of running.

The front wheel disc brakes are self-adjusting, and thus no attention of this kind is necessary.

plates incorporates the handbrake mechanism which

10:2 Rear brake overhaul

Each of the rear brakes is operated by a single hydraulic cylinder which, being free to slide on the anchor plate, exerts pressure equally from both ends, on the two shoes which abut it. Diametrically opposite the cylinder and at the bottom of the brake plate is the screw 'clicker' adjustment, associated with the other ends of the shoes. The shoes are supported by spring-loaded steady posts, which pass through the anchor plate and the shoe webs. Two pull-off springs are located between the shoes, the arrangement being clear from **FIG 10:4**. The operation is that hydraulic pressure causes the leading shoe abutting the piston, to contact the drum surface, so that further pressure causes the cylinder to slide, in the contra-direction, moving the trailing shoe into contact with the drum. On release of pressure, the shoes are retracted by

the pull-off springs, and the system is centralized by the rotating brake drum.

To examine the brake-shoes, the car is first jacked up and the road wheel and brake drum removed. Take out the single countersunk screw which holds the drum to the hub, and which ensures that the drum is retained when the road wheel is detached. This screw may be obstinate, but a few light blows on the screwdriver end will help to free it. The brake drum may then be taken off.

Withdraw the split-pins and remove the steady pins, cups and springs from the anchor plate and shoe webs. Disengage the rear brake shoe from its slot in the adjuster, the opposite end being also removed from the wheel cylinder. The springs will now be untensioned, allowing the other shoe to be lifted from its abutments, and the springs detached. It is also necessary when taking out the front shoe, to disengage it from the handbrake lever, which registers in a slot at the top of the shoe. It is advisable to encircle the brake cylinder with a rubber band, in such a way as to prevent the piston from coming out of the cylinder. **FIG 10:5** shows all details.

The backplate and all parts must next be cleared of dust and grease. Check that the wheel cylinder is quite free to

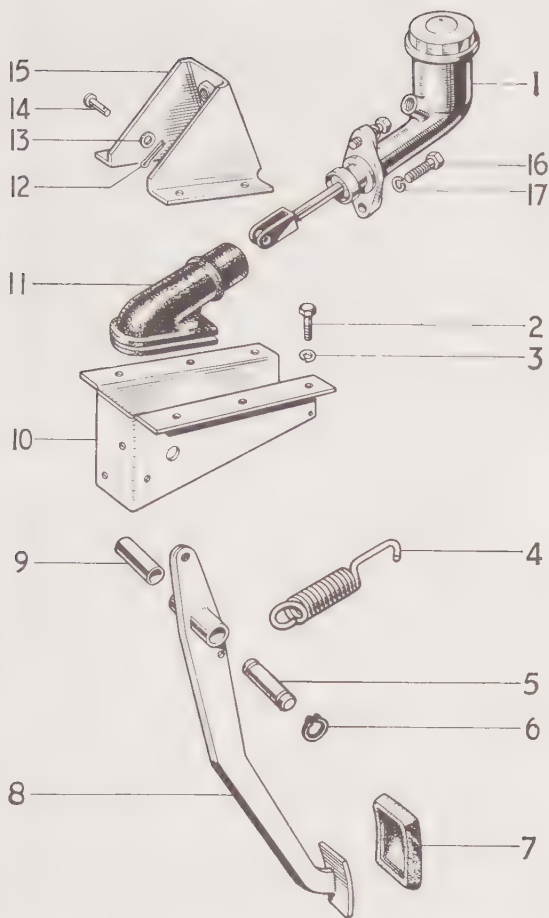


Fig 10:2 Arrangement of brake master cylinder, pedal and chassis brackets.

Key to Fig 10:2 1 Master cylinder. 2 Bolt. 3 Spring washer. 4 Return spring. 5 Pivot pin. 6 Circlip. 7 Pedal rubber. 8 Pedal. 9 Pedal pivot bush. 10 Pedal bracket. 11 Rubber dust excluder. 12 Split-pin. 13 Plain washer. 14 Clevis pin. 15 Master cylinder bracket. 16 Bolt. 17 Spring washer.

slide in its slot in the plate, and that there is no sign of fluid leakage. Make sure that the adjuster unit is in good condition, with the two tappets and the wedge moving freely; the latter should be turned to its fully-retracted position.

Examination of the brake shoes will show whether the linings are excessively worn, and if necessary they must be replaced with approved factory replacements, on which the linings are specially ground to size. This reduces the time required for bedding-in before the brakes are fully effective. Brake shoes must always be replaced as a set, and new pull-off springs are advised at the same time. Before replacing the shoes in position, lightly smear the slots in the adjuster and wheel cylinder with Girling white brake grease, and also apply a little to the steady posts. Take care that no grease gets on to the linings. Note that the pull-off spring with a single coil is fitted nearest to the adjuster, while the second spring which has two coils in

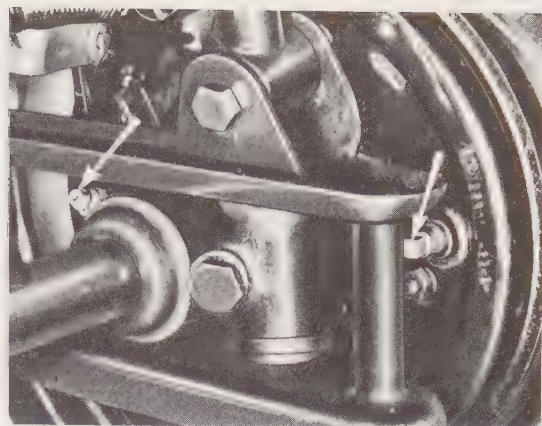


Fig 10:3 Rear brake backplate, showing, arrowed (left) bleed nipple (right), adjuster.

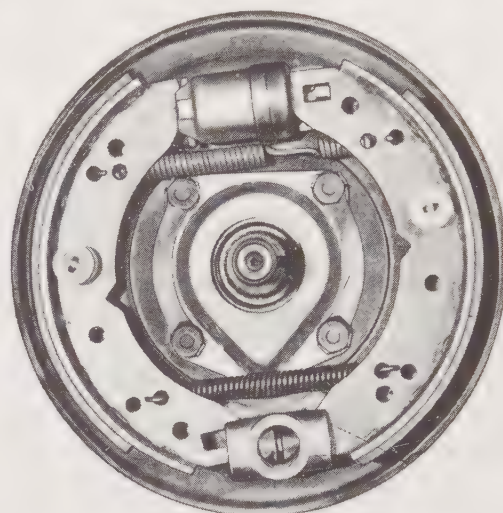


Fig 10:4 Rear brake with drum removed. Operating cylinder is at top, adjuster at bottom. Note positioning of pull-off springs.

tandem, is located adjacent to the wheel cylinder. The ends of the springs are hooked into the outer of the two holes in the webs, i.e. nearest to the steady posts. This can be clarified by reference to **FIG 10:4**.

The brake drum should be examined for signs of scoring, and must be replaced if defective. After refitting the drum and tightening the countersunk head screw, the brake should be adjusted, allowing an extra 'click' retraction of the adjuster when new linings have been fitted. Normal adjustment must be restored as soon as possible after bedding-in the linings.

The adjuster which serves as the uniting point of the shoe-ends opposite the cylinder, comprises a light alloy body which is bolted to the anchor plate. In the body are two sliding links or tappets, whose outer ends are slotted to take the ends of the brake shoes as already indicated. The inner ends of the tappets have inclined surfaces, which mate with the four flats on the coned head of a

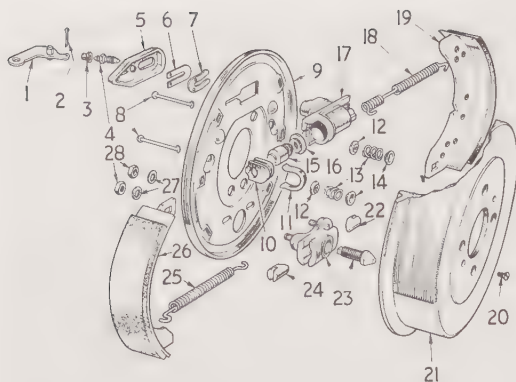


Fig 10:5 Components of rear brake assembly.

Key to Fig 10:5 1 Handbrake lever. 2 Split-pin. 3 Dust cap. 4 Bleed nipple. 5 Dust excluder. 6 Retaining clip. 7 Retaining clip. 8 Steady pins. 9 Backplate. 10 Dust excluder. 11 Clip. 12 Steady pin cups. 13 Springs. 14 Steady pin cups. 15 Piston. 16 Seal. 17 Wheel cylinder. 18 Return spring. 19 Brake shoe. 20 Countersunk screw. 21 Brake drum. 22 Adjuster tappet. 23 Adjuster wedge and body. 24 Adjuster tappet. 25 Return spring. 26 Brake shoe. 27 Shakeproof washers. 28 Nuts.

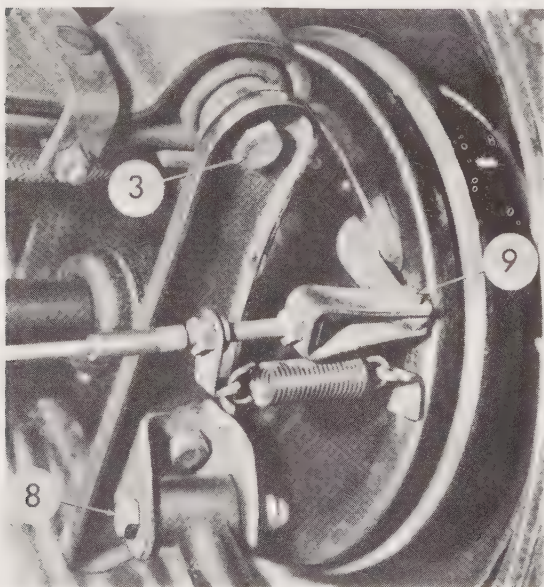


Fig 10:6 Rear brake backplate showing handbrake operation.

Key to Fig 10:6 3 Spring eye-bolt. 8 Tie-rod attachment. 9 Handbrake lever clevis.

hardened steel wedge having its axis at 90 deg to the tappets, and its shank protruding through the backplate with a squared head. All these parts can be identified on **FIG 10:5**. By turning the head clockwise, the two tappets are forced apart, which expands their fulcrum point and brings the lined shoes nearer to the drum.

If the expander is worn, it should be replaced with another unit. It can be removed after taking off the brake shoes, by withdrawing its two tappets and unscrewing

the nuts holding the unit to the backplate. The wedge is taken out by rotating it clockwise, when the squared head will pass through the body. When reassembling, make sure that the two tappets are replaced in their original positions, and smear the slots of the links lightly with Girling white brake grease.

If it is desired to remove the backplate from the axle, the roadwheel and brake drum are removed as before, and the handbrake cable disconnected from the backplate lever by taking out the split-pin and clevis (see **FIG 10:6**). The hydraulic system must be emptied of fluid through one of the bleed nipples as described later. Then detach the flexible hose. Withdraw the wheel hub as explained in Chapter 7. Turn up the locking tabs on the four setscrews which secure the backplate, and take out the screws. The grease trap, backplate and oil seal housing can then be removed. When replacing the backplate and wheel hub, careful reference should be made to Chapter 7.

10:3 Brake cylinders

Leakage of fluid or other trouble with the wheel cylinders can be remedied by the renewal of certain parts. However, this is a fairly exacting operation, and much the best course in the event of any trouble, is to remove the cylinder complete and fit a replacement; this ensures that all components are simultaneously restored to a state of full efficiency. The cylinder on each of the rear brake back-

operates the shoes mechanically. The cylinder has an alloy body and a piston with seal, a clip-secured rubber dust-cover being fitted over the open end of the cylinder. The body is slotted to accommodate the nose of the trailing brake shoe, while the piston has a nose for contacting the end of the leading shoe. At the open end of the body is cast a boss to take the pivot of the mechanical-operation lever which is pulled by the handbrake cable. The lever is of bellcrank type, its longer end protruding through a backplate slot and being coupled to the pull-cable, while its short end locates a slot in the end of the brake shoe.

The cylinder is free to slide in the backplate, so facilitating the centring action of the shoes. It is held in position by two spring clips located under the dust cover on the outside of the backplate.

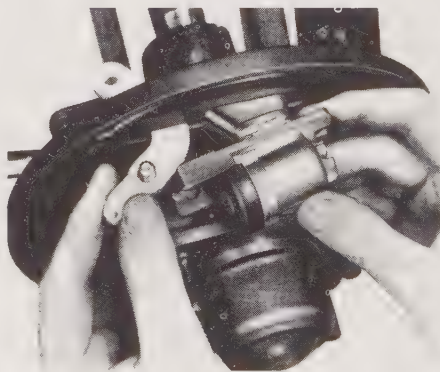


Fig 10:7 Withdrawal of operating cylinder and handbrake lever from rear brake backplate.

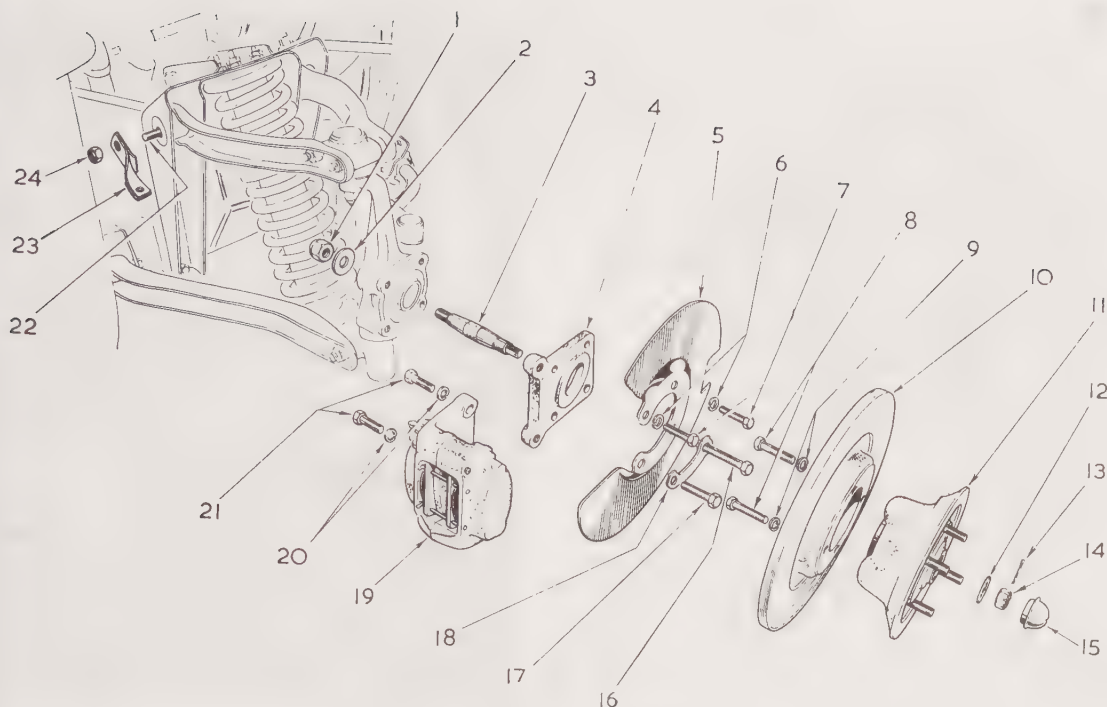


Fig 10:8 Components of front brake assembly.

Key to Fig 10:8 1 Nyloc nut. 2 Washer. 3 Stub axle. 4 Caliper mounting bracket. 5 Disc shield. 6 Spring washers. 7 Bolts. 8 Bolts. 9 Spring washers. 10 Disc. 11 Hub. 12 Washer. 13 Split-pin. 14 Slotted nut. 15 Cap. 16 Bolt. 17 Bolt. 18 Lock plate. 19 Caliper assembly. 20 Spring washer. 21 Bolts. 22 Bolt. 23 Bracket. 24 Nyloc nut.

To remove the cylinder after the brake shoes have been taken off, the handbrake cable is first uncoupled at the clevis, and the hydraulic pipe union unscrewed. By pushing the dust cover aside and taking out the spring clips, the pivot of the bellcrank lever can then be eased out of its fulcrum, and the cylinder withdrawn from its slot in the backplate, as shown on **FIG 10:7**.

When refitting, make sure that the cylinder is quite free in the backplate slot; this is most important. With the cylinder positioned and the bell-crank lever in place, the assembly can be secured by fitting the spring clips. Fit the dust cover, and check that the cylinder is completely free to slide. After coupling up the handbrake, its operation must be checked as described later.

10:4 Front brake overhaul

The disc-type front brakes are self-adjusting and comprise a wheel disc, in conjunction with a double-acting caliper unit having two friction pads, which are quickly detachable for examination and replacement. The components are shown on **FIG 10:8**.

The brake caliper housing straddles the brake disc, and is secured to the vertical suspension link by a mounting bracket and bolts, as shown on **FIG 10:9**. A circular disc shield is also mounted on the same bracket, thus protecting the inner face of the disc from road filth. In the caliper housing, and on each side of the brake disc, a segment type brake pad is located with an operating piston behind

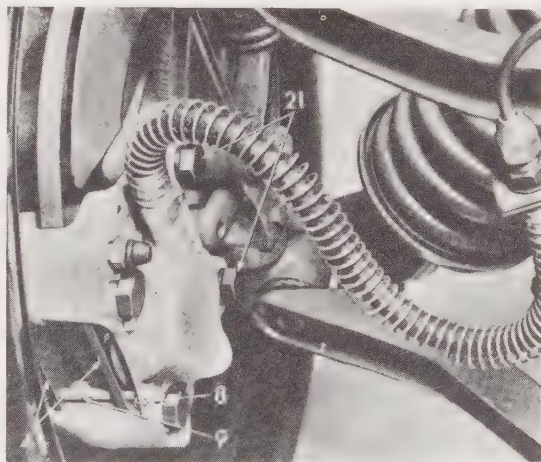


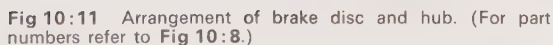
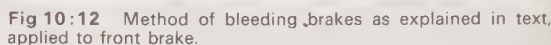
Fig 10:9 Arrangement of caliper housing and flexible pipe, on front brake.

Key to Fig 10:9 4 Brake pads. 8 Retaining clip. 9 Retaining pin.

it, so that in operation the disc is 'nipped' between the two pads advancing towards each other. The construction is shown on **FIG 10:10**, from which it will be noted that the hydraulic fluid is conveyed from an external pipe union via passages in the caliper housing, to the two pistons



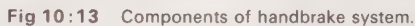
Key to Fig 10:10 1 Rubber 'O' ring. 2 Fluid ducts. 3 Body. 4 Brake pads. 5 Anti-squeal plate. 6 Piston. 7 Piston sealing ring. 8 Dust cover. 9 Retaining clip. 10 Retaining pin. 11 Fluid pipe union. 12 Bleed nipple.



operating the pads. A bleed valve is provided on the outside, at the fluid entry.

The brake pads should be inspected periodically to ascertain the rate of wear. Pad assemblies cannot be re-lined, and must be replaced when wear is excessive. To remove the pads the two retaining pins (**FIG 10:10**) are withdrawn after taking off their spring clips. This allows the pads to be slipped out of the housing. Before fitting new pads, the operating pistons must be pushed back to the full limit of their travel. After fitting the pads and the retaining pins, make sure that the spring clips on the latter are correctly replaced and firmly located.

When the pads are removed, the dust sealing arrangements on the pistons should be examined, for signs of deterioration. If defective they must be replaced. To do this, the caliper assembly is removed by uncoupling the flexible pipe and taking out the two bolts holding the caliper to the support bracket. The two pistons are then withdrawn. In addition to the rubber bellows, there is a rubber sealing ring for each piston, located in a groove as shown on **FIG 10:10**. This must be renewed at the same time as the bellows. The whole of the operating mechanism must be carefully cleaned, using brake fluid as a cleansing liquid, and nothing else. When reassembling, make sure that the piston sealing rings are properly fitted into their grooves. Next locate the lip of the rubber bellows into the groove on the outside of the cylinder. The piston is then inserted with its closed end leading. When it is fully home, the lip of the rubber bellows can be fitted into the groove on the outside of the piston. The pads are then refitted as already described, and the caliper assembly



replaced on the car, tightening the bolts to a torque of 50–55 lb/ft. The brakes must then be bled as described later.

The maximum allowable run-out on the disc at the friction surfaces, is 0.002 in (0.0508 mm). For correction of this, or any other defect such as scoring, the disc can be removed after taking off the brake caliper as already detailed. The hub construction shown on **FIG 10:11** is as described in Chapter 8. The end-cap of the hub has a tapped hole at its centre, which facilitates its removal by screwing-in a No. 10 UNF setscrew, to act as a jacking screw which forces the cap off.

tightened to a torque of 32–35 lb/ft. The hub is then reassembled and carefully adjusted, as described in Chapter 8.

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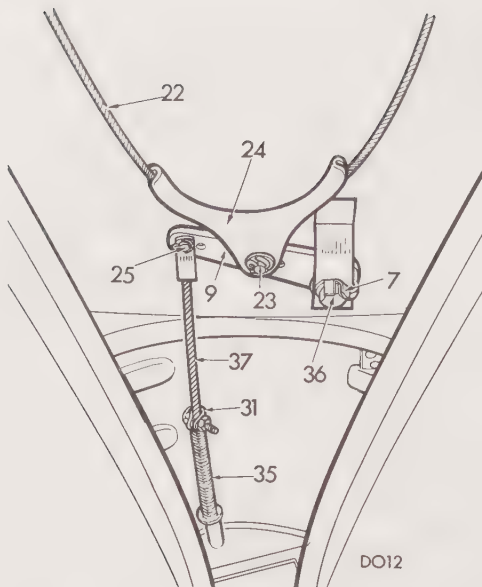


Fig 10:14 Handbrake relay lever and compensator. (For part numbers refer to Fig 10:13.)

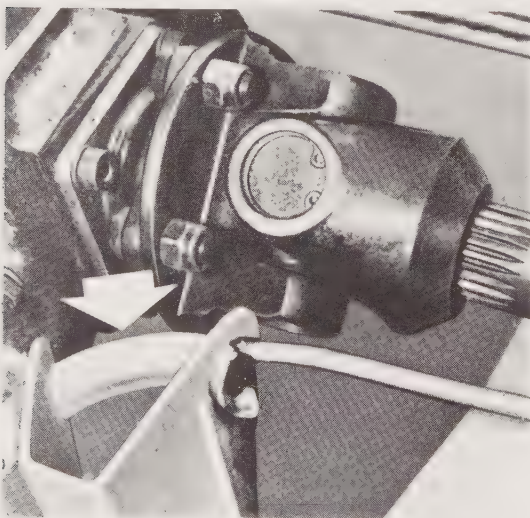


Fig 10:15 Guide for handbrake cable located near differential unit.

than brake fluid of an approved type has been put into the system, it must be completely flushed out with methylated spirits, and the rubber seals replaced with new ones. The system is then filled with fluid and bled.

The bleed valves are located on the front cylinders of the front brakes, and on each of the rear brake cylinders, and are of course accessible from the outside of the backplates. The valves and the surrounding area of the backplates should first be cleaned, and work started on the rear wheel cylinder farthest away from the master cylinder. Turn the brake adjuster clockwise so as to lock the shoes against the drum; this ensures that there is the minimum

fluid capacity in the wheel cylinder, and hence less liability of air being present. Attach a rubber or plastic bleed tube to the valve nipple, and lead the free end of the tube into a jar containing clean fluid, ensuring that the end of the tube is below the fluid surface, as shown on **FIG 10:12**. Next open the bleed valve about a quarter turn, and with the help of an assistant, pump the brake pedal to the floor, taking care that the pedal movement is not impeded in any way by the floor covering. Release the pedal smartly, and take time to allow the master cylinder to fill from the reservoir. (Ensure that the reservoir is kept fully supplied throughout.) Repeat the process several times, and note that fluid is being discharged into the jar, along with any air present. If this does not happen, check that the pipeline is not blocked and that the valve is properly open. When fluid which is completely free from air bubbles emerges from the tube throughout the pedal stroke this is satisfactory, and the bleed valve must then be shut off while holding the pedal fully depressed. Tightening torque for the bleed valve is 5–7 lb/ft.

The operation is repeated on the other rear brake, followed by the front ones, and finishing at the wheel cylinder nearest to the master cylinder. The locking-on procedure is of course not possible in the case of the front brakes, the bleed valves for which are located adjacent to the flexible pipe union at the top of the caliper. Finally the fluid reservoir should be topped up to the correct level and the shoes readjusted as necessary. Fluid bled out of the system should not be re-used, as it may contain dirt or air-bubbles. New fluid should always be obtained out of a container which has been sealed from the atmosphere, as exposure lowers the boiling point of the fluid. In any case and in the interests of cleanliness, never accept fluid from an open can.

10:7 Vacuum servo unit

If desired, a servo unit can be fitted which utilises the sub-atmospheric pressure in the induction manifold to apply the brakes. This is the 'Girling Powerstop' type, and is readily installed by a Triumph agent, or brake specialist. The general arrangement of the pipelines to the brakes is not affected, and in the unlikely event of servo failure, the normal system is still operable. The servo unit incorporates an intake air filter which is housed under a cover retained by a single screw. The filter element must be replaced by a new one whenever brake shoe replacement or other overhauling work is being carried out.

The seals in the unit must be renewed at 36,000 mile intervals, and to meet this condition the best course is to replace the complete servo assembly on an exchange basis. This ensures that, apart from the seals, all internal working surfaces will be in good condition.

10:8 Handbrake

The handbrake operates on the rear wheels by actuating the shoes through levers on the wheel cylinders as already described. The handbrake lever is mounted between the seats and operates the backplate levers via a cable system. The arrangement is shown on **FIG 10:13**.

A single flexible cable is attached to the handbrake lever by an adjustable screwed shank and clevis, and is coupled at its rear end to a relay lever pivoted on the frame.

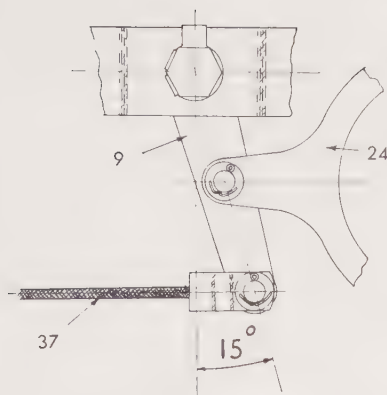


Fig 10:16 Angular positioning of handbrake relay lever with correct cable adjustment.

Key to Fig 10:16 9 Relay lever. 24 Compensator sector. 37 Cable to control lever.

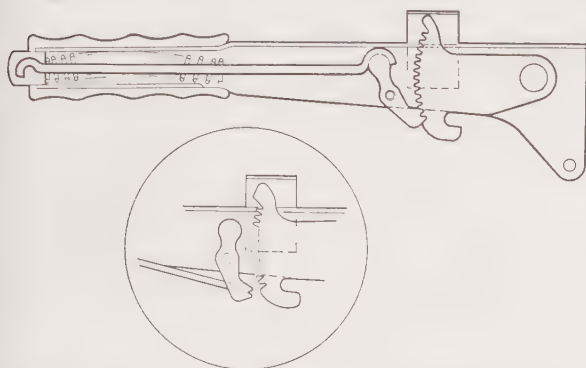


Fig 10:17 Section of handbrake control lever. Inset shows reversed 'fly-off' ratchet used on some 'Spitfire' and G.T. Six cars.

This lever is attached to a sector-shaped compensator (**FIG 10:14**), round which passes a second cable connecting the two backplate levers. The compensator sector thus balances the pull from the relay lever divided equally to both rear brakes. The secondary cable is carried in suitable guides to provide a straight pull on the backplate levers, as shown on **FIG 10:15**. To adjust the cable, the rear wheels should be jacked up and the brake drums locked by screwing each adjuster fully in. The cable and pull-off spring (if fitted) is next disconnected at each backplate lever.

The cable to the handbrake lever must now be adjusted at the forward screwed shank, until the relay lever assumes the angular positioning shown on **FIG 10:16**. This is done by slackening the locknut and adjusting nut on the shank; tighten the nuts when all is correct.

The two clevises at the ends of the rear cable must next be adjusted by equal amounts, until all the slackness has been taken up, whilst still allowing the clevis pins to be inserted easily into their holes. When all is well, fit new split-pins to the clevis-pins, and check that the adjusting nuts are tight. The pull-off springs (**FIG 10:6**) should have their brackets adjusted to provide a moderate tension

on the springs. The brakes should then be adjusted in the normal manner by means of the 'clicker' adjusters.

Should the rear cable appear sluggish in operation, it should be detached at its ends, and greased liberally where it passes over the guides and compensator. If the cable is worked to and fro in the guides this will assist in distributing the grease. If it is desired to remove the handbrake lever (**FIG 10:17**) for renewal of worn parts, the cable must first be detached at the clevis. With the front seats, carpet cover and gaiter removed, the circlip and washer can be taken off the pivot pin of the lever, and the pin withdrawn. The lever can then be turned so as to allow the ratchet to come clear of the floor bracket and lifted off.

The lever components are dismantled by driving out the pawl pin, and removing the pawl, spring and rod with release button, in that order.

The cable can be withdrawn by detaching it from the relay lever at the rear end, and taking off the clevis fork and nuts from the screwed shank at the front end. The cable is then removed from below the car.

If the handbrake pawl and ratchet are worn they must be replaced, as their function is most important. When re-assembling, these parts should be lightly smeared with grease. A new pin must be used at the pawl pivot, and its end firmly riveted over. When refitting the front cable, make sure that when the handbrake is fully on, the coils of the compression spring do not close right up. If necessary the spring can be adjusted by means of the clamp encircling the cable. The spring should be compressed about 1 in (25 mm) when the brake is off.

Both cables should at all times be sound, and should any fraying or other deterioration be apparent, the cable must be replaced.

10:9 Fault diagnosis

(a) 'Spongy' pedal

- 1 Leak in the system
- 2 Worn master cylinder
- 3 Leaking wheel cylinders
- 4 Air in the system
- 5 Gaps between shoes and underside of linings

(b) Excessive pedal movement

- 1 Check 1 and 4 in (a)
- 2 Excessive lining wear
- 3 Very low fluid level in supply reservoir
- 4 Too much free movement of pedal

(c) Brakes grab or pull to one side

- 1 Brake backplate loose
- 2 Scored, cracked or distorted drum or disc
- 3 High spots on drum
- 4 Unbalanced shoe adjustment
- 5 Wet or oily linings
- 6 Worn or loose rear suspension fixings
- 7 Front suspension or rear housing anchorages loose
- 8 Worn steering connections
- 9 Mixed linings of different grades
- 10 Uneven tyre pressures
- 11 Broken shoe return springs
- 12 Seized handbrake cable

CHAPTER 11

THE ELECTRICAL SYSTEM

11:1 Battery
11:2 State of charge
11:3 Generator
11:4 Brushes
11:5 Field coils
11:6 Starter

11:7 Starter assembly
11:8 Regulator unit
11:9 Cut-out action
11:10 Setting of points
11:11 Windscreen wiper
11:12 The horn
11:13 Fault diagnosis

The electrical system is of the 12-volt type. On earlier cars the positive battery pole is earthed in accordance with long-established practice, but later types have adopted the earthed negative system which is rapidly coming into use. It is most important to bear this in mind when fitting certain accessories, notably radios, as serious damage can result if incorrectly connected. Also, should any components of the electrical equipment require replacement, care should be taken to obtain the correct pattern, the discarded part being used for identification. All components and circuits are of straightforward automobile-electrical design, and as is generally accepted, faults in the main components in such installations are usually dealt with by the substitution of exchange units. Again, the equipment required for testing is usually of a type produced mainly for service stations.

Nevertheless, for the information of owners possessing adequate electrical knowledge, details of certain tests are given which it is possible to carry out using standard precision electrical meters. It must however be emphasised that the latter must be of the type stated; no rough-and-ready or doubtful apparatus is good enough, as the information given has to be accurate within very close limits. Wiring diagrams covering the various cars are given in the Appendix. If recourse to these is necessary, the comments just made regarding expertise should be borne in mind, as incorrect interpretation of such

diagrams is a not infrequent cause of subsequent trouble. For assemblies such as the generator and starter, it is possible in the event of bearing or similar replacements being required, partly to dismantle units by using standard tools, and this may in some cases give a saving in cost.

The reliable functioning of the system depends to a very large extent on the battery, but this is a component whose life is inherently limited by the nature of its work. Very long and trouble-free service is, however, obtainable provided maintenance is carried out at stipulated intervals, while neglect will obviously encourage early failure.

11:1 Battery

The battery is accessibly housed in the engine compartment, and is of clean-top type with die-cast screw-retained connectors. Various improvements have been made to batteries recently, generally aimed at easier topping-up, but regardless of the type of filling system, the battery top and exterior should be kept clean at all times since a film of moisture and dirt encourages electrical leakage and the building up of resistance in the main connections. The latter should be kept tight and smeared with petroleum jelly over the clean metal, which will help to maintain a good connection and prevent corrosion. The jelly coating should be wiped off whenever it becomes very dirty, and freshly re-smeared. When topping-up, the

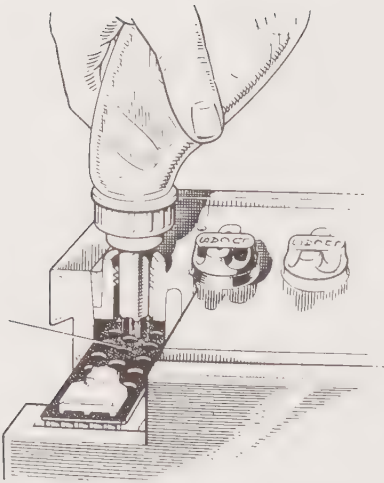


Fig 11:1 Use of Lucas filler for topping-up battery.

use of a special battery filler, as **FIG 11:1**, will be found most useful; care must at all times be taken not to spill water or, in particular acid, over the battery top. If any is spilt it must be soaked up immediately until the top is clean and dry. A weak solution of ammonia and hot water will combat any corrosion from this cause, but its use is not really necessary so long as the above action is taken at once, or the acid content is excessive.

The correct electrolyte level is just to the top surface of the separator guard, which can be seen on **FIG 11:1**. Never over-fill the battery, otherwise electrolyte will escape through the vent-holes in the filler plugs; these holes should always be kept clear, and the plugs screwed in tightly, by hand. Soft or distilled water must always be used for topping-up, and water which is salt, chlorinated, chemically-softened, or stagnant, must never be used.

Batteries having an easy-filling feature will automatic-

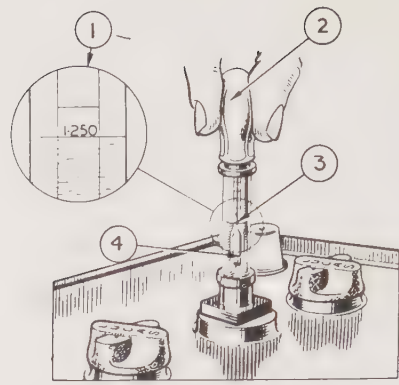


Fig 11:2 Use of hydrometer for checking specific gravity of electrolyte.

Key to Fig 11:2 1 Hydrometer reading. 2 Hold vertically. 3 Draw in correct amount. 4 Check that float is free.

ally top-up to the correct fluid level in all the cells when the water is poured into the trough provided; the only precaution necessary is to ensure that the trough is clean and not overfilled. The trough cover should be replaced immediately, this allowing the fluid to flow into each cell to the correct level.

If the battery is topped-up immediately before running (or of course during a journey) this is good practice, as the electrolyte becomes quickly mixed in these conditions, and also freezing is prevented in very cold weather. The need for too frequent topping-up indicates either excessive charging or a leaking case. The latter is likely to be the cause if one cell requires more fluid for topping-up than another. Repair of a minor leak is possible but it is advisable to entrust this to a battery service station. If excessive charging is suspected, the regulator can be checked (subject to earlier comments on the knowledge and use of electrical instruments) as detailed later.

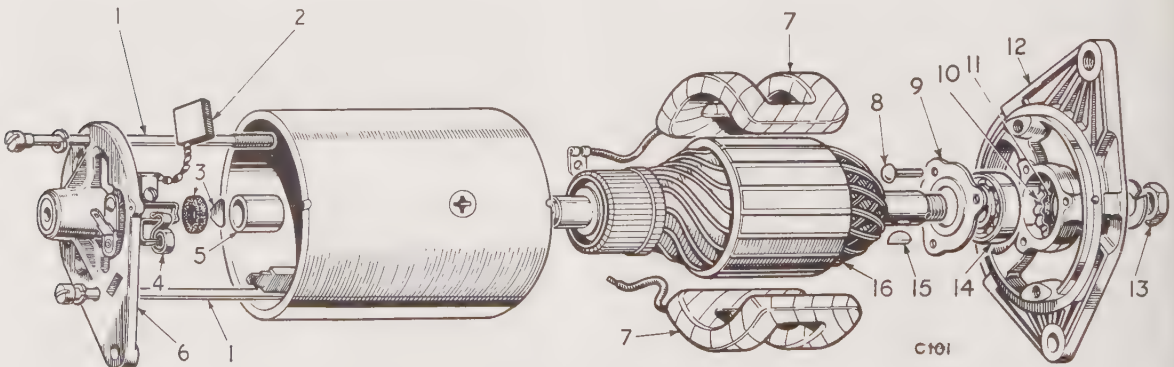


Fig 11:3 Components of generator.

Key to Fig 11:3 1 Bolts. 2 Brush. 3 Felt ring and aluminium sealing disc. 4 Brush spring. 5 Bearing bush.
6 Commutator end bracket. 7 Field coils. 8 Rivet. 9 Bearing retainer plate. 10 Corrugated washer. 11 Felt washer.
12 Driving end bracket. 13 Pulley retainer nut. 14 Bearing. 15 Woodruff key. 16 Armature.

11:2 State of charge

The state of charge of the battery may be checked at any time by a hydrometer, which measures the specific gravity of the electrolyte, as shown on **FIG 11:2**. The sp.g. will vary somewhat according to climatic temperature, as shown below:

Climate normally below 32°C or 90°F

Fully charged cell	1.27–1.29
Half charged cell	1.19–1.21
Fully discharged	1.11–1.13

Climate normally above 32°C or 90°F

Fully charged cell	1.21–1.23
Half charged cell	1.13–1.15
Fully discharged	1.05–1.07

The figures are for an electrolyte temperature of 15.6°C (60°F). Above this figure, add 0.002 to the hydrometer reading for each 2.8°C (5°F) rise, to obtain the true sp.g. figure, and deduct similarly for readings required below 15.6°C. The temperature must be measured by means of a thermometer with its bulb in the electrolyte. Spillage of electrolyte and topping-up with plain water will of course lower the sp.g. and this is undesirable. The correct method is to check the sp.g. of the electrolyte in the battery and then top up with a solution mixed to an identical figure. Never add water to acid when mixing externally; the acid must always be added to the water. The hydrometer is quite a satisfactory method of ascertaining both the condition of the electrolyte and the state of charge. Service stations have other instruments which can be used for a quick check, and the relevant figures may be of use, as follows.

The open-circuit voltage of the battery should be about 12.6 volts (or 2.1 volts per cell) when in good condition and not charged for the previous 12 hours. However, although a low open-circuit voltage certainly indicates a battery in poor condition, the reverse, i.e. high voltage, does not necessarily give any guide to the opposite effect; a rapid discharge may well show an incapacity to maintain this, which is an important matter when using the starter. Thus, a high-discharge test is required. In these conditions the battery should give a current of 100 amp for 10 seconds without any appreciable voltage drop. The usual instrument for this purpose which incorporates a low-resistance bridge, will show a cell voltage steady between 1.2 and 1.5 volts for this period when its prongs are pressed into adjacent cell interconnectors. When this test is done, the battery should of course be in a good everyday state of charge. If the battery is out of action completely for a long period, it must be given a topping-up charge at least once per month.

11:3 Generator

The type of generator fitted to individual cars may vary in minor details, and particulars are given in the Appendix. In all cases however the general specification, and procedure for overhaul, are covered by what follows.

The generator is of the two-brush type, belt-driven from the crankshaft. It operates in conjunction with an automatic current-voltage regulator and cut-out. The output voltage of the generator can be checked by disconnecting

the terminals marked D and F, joining them with a loop of wire, and connecting a voltmeter reading 0–20 between the loop and earth. The engine is then run at idling speed, and when speeded up a little the voltage reading should rise steadily and without fluctuation. There is no point in attempting to obtain any arbitrary maximum reading, such as 20 volts, and the engine must not be revved excessively to this end. Note at the same time whether there is excessive sparking between the brushes and commutator.

If a very low reading, or none at all, is the result, the brush gear and windings of the machine must be examined. To assist in tracing faults, a further test can be applied if an ammeter is available. Slacken the generator mountings and remove the belt. Then connect the ammeter between the terminals joined as above and the negative terminal of the battery. This will cause the machine to run as a motor, with the ammeter reading 3 to 5 amp. If this reading is higher, it indicates excessive friction, e.g. tight bearings, or possible short circuits. A low reading generally shows high resistance, which could be caused by a commutator in poor condition, or faulty brush contact giving generally bad commutation.

The generator may be partially dismantled for inspection or rectification, by first removing it from the engine (Chapter 1), after which the nut and lock-washers are removed from the shaft end and the pulley and spacer taken off; take care to avoid damage to the pulley. Work will be facilitated by reference to **FIG 11:3** for identification of the parts. The two long bolts are next unscrewed from the opposite end of the machine. The bearing end bracket at this end can be taken off, and the end bracket complete with shaft and armature pulled from the other end; also remove the pulley key. Should it be considered that the drive-end bearing, windings, or commutator require attention, this work should be given to an approved electrical service station. The same remark applies to renewal of the bush in the commutator end-bracket.

11:4 Brushes

The brushes can be renewed by lifting up the springs, taking out the brushes from their holders, and removing the screws securing the ends of the brush leads to the holders. To reassemble after repairs, etc., the brushes are first positioned in their holders and held in the raised position by allowing the brush springs to ride with their ends on the sides of the brushes instead of on the top. Then fit

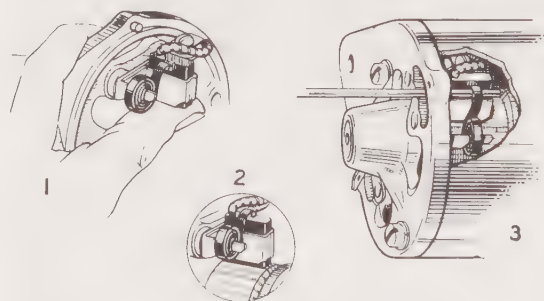


Fig 11:4 Sequence of releasing brushes to commutator.

Key to Fig 11:4 1 Trapped in raised position. 2 Normal running position. 3 Method of releasing from 1 to 2.

the end bracket over the armature with its bush on the shaft, release the brushes and position their springs properly. The sequence is shown on **FIG 11:4**. Pull each brush in turn away from its contact with the commutator, by pulling on its lead. The brush movement must be free without shake, but if at all imprecise or sluggish, take the brush out of the holder and carefully ease it with a smooth file, on the sides as shown to be appropriate. Do not overdo this process, as this will introduce undue shake; and always fit brushes in the same original positions. Brush replacement is necessary when the length is reduced to $\frac{1}{2}$ in.

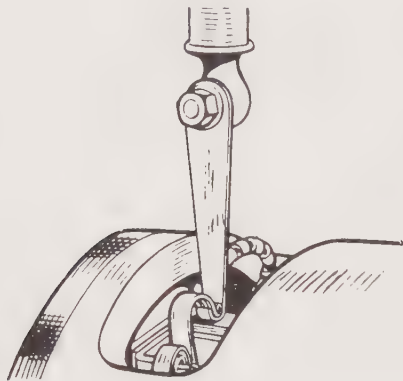


Fig 11:5 Use of spring balance for checking tension of brush springs.

If desired the brush spring tension may be checked by using a small spring balance as shown on **FIG 11:5**. With a commutator diameter of 1.48–1.485 in the tension on a new brush should be 30 oz maximum, and on a brush worn to the limit $\frac{1}{2}$ in, 15 oz. If the tension is less, new springs are called for.

To continue with reassembling the machine, the commutator end bracket is again removed and the brush leads secured by their screws to the holders. The driving end bracket complete with armature can be fitted, with the dowel in the bracket engaging the groove or hole in the machine casing. Raise the brushes in their holders and locate them in this position as previously. Fit the fibre thrust washer over the end of the shaft and put the end bracket over the shaft end. Then position the bracket with its dowel engaging the body, as for the opposite end. The two long bolts are then inserted and tightened securely. By using a small screwdriver or similar thin tool, the brush springs can now be levered up into their correct position, with their ends on the tops of the brushes (**FIG 11:4**) and the brushes correctly contacting the commutator. The pulley spacer, shaft key, pulley washer and locknut are then replaced in that order.

The commutator end bearing bush must be lubricated by forcing a few drops of thin engine oil into the hole at the end of the bearing boss which is shown on **FIG 11:6**. The machine is then replaced on the engine in accordance with details given in Chapter 1. The ignition warning light on the dashboard indicates that the generator is charging. It should light when the ignition is switched on, and will remain illuminated when the engine is stationary or idling

very slowly. As speed increases the generator voltage builds up. This opposes the battery voltage applied to the lamp, causing light to fade until the voltage build-up is sufficient to operate the cut-out. This action short-circuits the lamp which then goes out.

11:5 Field coils

The field coils can be checked without removing the machine, by taking the lead off the F-terminal, and connecting this to an independent 12-volt battery with an ammeter in series. A lead from the other battery terminal is then 'touched' on the generator casing. A voltmeter must also be connected between the F-terminal and the casing. Using Ohm's Law, the voltage reading is divided by the current reading to obtain the resistance in Ohm; this should be 6, i.e. the current is 2 amp. If the resistance is below 5.9 Ohm as indicated by a registered excess of current, it indicates faulty field coil insulation. The car battery (disconnected of course from its normal circuit) may be used for this test.

11:6 Starter

The starter motor is constructed mechanically on generally similar lines to the generator, but of course its design electrically is quite different; components are arranged as in **FIG 11:7**. The starter has four sets of field coils and four brushes, the main electrical input being taken to the field coils, the other ends of which are connected to two of the brushes. From these brushes the current passes to the commutator and armature, and thence back to the remaining two brushes which are earthed.

The armature shaft has a square machined thereon at the commutator end, which enables a spanner to be used to turn the shaft in the event of the starter pinion jamming; the square is normally covered by a pull-off metal cap. It is necessary to remove the starter from the engine as detailed in Chapter 1, before carrying out any maintenance work. Having done this, the cover band can be taken off, and both end brackets removed by withdrawing the two long bolts, as in the case of the generator. This will of course withdraw the armature complete with driving pinion assembly.

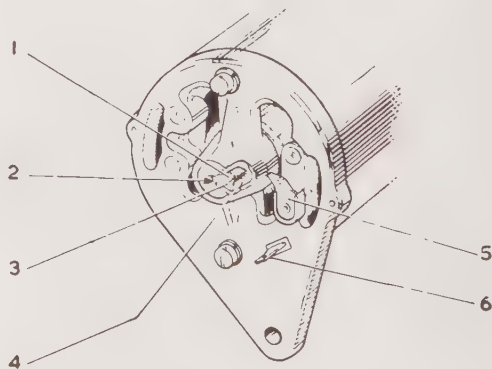


Fig 11:6 Commutator-end bracket of generator.

Key to Fig 11:6 1 Felt ring retainer. 2 Oil hole. 3 Felt ring. 4 Porous bronze bush. 5 Output terminal D. 6 Field terminal F.

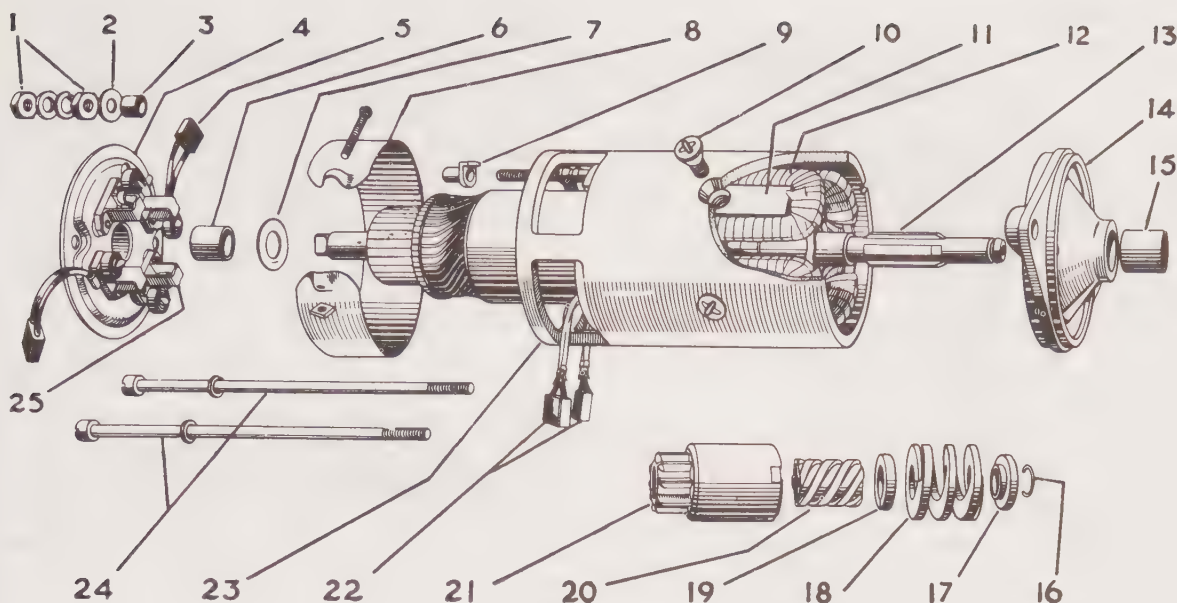


Fig 11:7 Components of starter motor and drive.

Key to Fig 11:7 1 Terminal nuts and washers. 2 Insulating washer. 3 Insulating bush. 4 End plate. 5 Brush. 6 Bush. 7 Thrust washer. 8 Cover band. 9 Insulating bush. 10 Pole securing screw. 11 Pole piece. 12 Field coil. 13 Shaft. 14 End bracket. 15 Bush. 16 Jump ring. 17 Retainer. 18 Main spring. 19 Thrust washer. 20 Sleeve. 21 Pinion and barrel assembly. 22 Brushes. 23 Yoke. 24 Through bolts. 25 Brush box.

The brush springs are next lifted, and the brushes examined for free movement up and down in their holders. They may require cleaning with a cloth moistened in petrol, and if considered advisable may also be eased on their sides to ensure free movement as in the case of the generator brushes. Brush replacement is necessary when the length is reduced to $\frac{5}{16}$ in. The brush leads are sweated to their connections, and after unsoldering them, the new leads must be carefully secured by the same means, ensuring that no solder runs down the lead towards the brush, and that the clips are properly tinned and clenched up before soldering. Note that the leads of the brushes attached to the field coils have a braided covering and that they are longer than those of the earthed brushes, as shown on FIGS 11:8 and 11:9. If the strength of the springs is inadequate these may be renewed, taking care to close the ends of the spring posts after fitting new springs. Tension can be checked with a spring balance, as in the case of the generator brushes. The insulation of the brush holders can also be tested with a tell-tale lamp. The two field-coil brushes must also be positioned so that they point to the main input terminal located on the inner periphery of the machine casing, and which is connected to the other end of the field windings. This post has a fibre sleeve and washers thereon, to insulate it from the end bracket through which it passes (FIG 11:7). There is also an internal band of insulating material between the casing interior and the ends of the four field coils at this end; make sure this is positioned correctly.

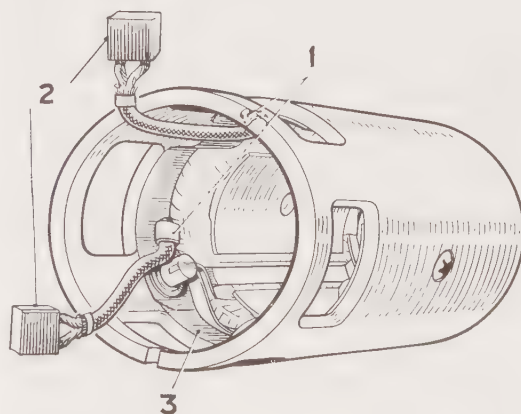


Fig 11:8 Insulated leads from field coils to brushes.

Key to Fig 11:8 1 Field coil connections. 2 Brushes. 3 Body.

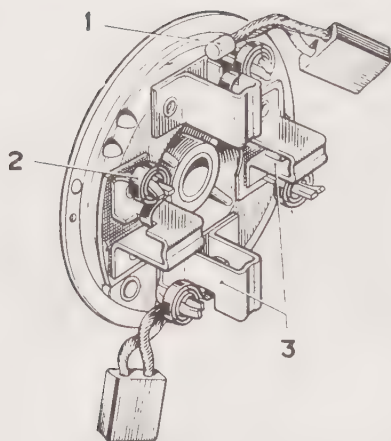


Fig 11:9 Uninsulated leads from end bracket to brushes.

Key to Fig 11:9 1 Eyelets. 2 Brush springs. 3 Brush boxes.

11:7 Starter assembly

Assuming that no specialist work is required on the field coils, the commutator end bracket can be refitted to the casing, but first the brushes attached to the field coils must be passed through the openings in the casing. Locate the end bracket on the casing with its dowel engaged properly in the notch on the casing. Then pass the two earthed brushes through the other two openings in the casing. Fit the washers and terminal nuts in the correct order on the terminal post (see **FIG 11:7**) and securely tighten the first of the nuts fitted. If no special work is required on the armature, bearing, or pinion and drive, this unit may be replaced. The dowel pin in the end bracket is engaged in the notch at this end of the frame; the two long bolts may then be replaced and securely tightened. The brush springs are now lifted by means of a hooked wire and the brushes put back into their holders, noting that the field coil brushes must be in the insulated holders. Check that all is correct and replace the cover band. The machine may then be refitted to the engine.

When the armature is withdrawn, the commutator can be cleaned with a cloth dampened with petrol. It is not advisable to use any abrasive; judicious use of fine glass-paper may have some effect, but is probably hardly worthwhile. There are obvious dangers in employing anything more drastic such as emery cloth, and in general faulty commutation is best remedied properly by having the commutator expertly skimmed in a lathe.

Armature trouble such as a bent shaft or faulty winding, is properly remedied by fitting a replacement component. The bearings also comprise porous metal bushes, and should have specialist attention if replacement is necessary.

The starter pinion and drive assembly should be checked to ensure that the pinion can move freely along the splined sleeve. If dirt is present this may prevent free movement, and must be washed off with petrol followed by a light film of oil.

If components are damaged, the drive may be dismantled. If the motor is of the type having a shaft nut and split-pin, as shown in **FIG 11:10**, the split-pin is first removed and the shaft held by its squared end while the nut is unscrewed. The main spring and buffer washer can then be taken off, and the retaining ring removed from the pinion and barrel assembly. The control nut, sleeve, and retaining spring will slide off in that order. The splined washer can then be removed followed by the pinion and barrel. After renewal of defective parts, assembly is generally a reversal of the foregoing. The screwed sleeve and control nut should never be replaced individually, but always as a unit.

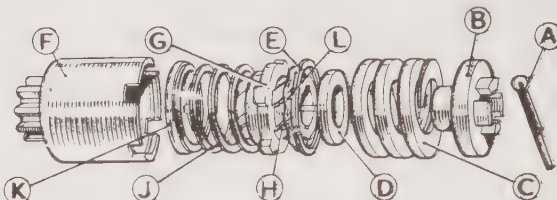


Fig 11:10 Type of drive assembly fitted to earlier starter motors.

Key to Fig 11:10 A Split-pin. B Nut. C Main spring. D Buffer washer. E Retaining spring. F Pinion and barrel. G Control nut. H Sleeve. J Retaining spring. K Splined washer. L Corrugated washer.

If the starter drive is of the type shown on **FIG 11:7**, this has a circlip at the shaft end instead of a nut and split-pin. To remove the circlip, a press must be used to push the retainer clear, so as to allow the circlip to be sprung off the shaft. The components are then removed from the shaft as already detailed, and when reassembling the press should be used to locate the retainer while a new circlip is fitted firmly into its groove. The press may then be released.

The starter switch is solenoid-operated, and for test purposes can be worked by hand, by pressing on the rubber cap which covers the plunger. In the event of trouble, the switch complete should be exchanged.

11:8 Regulator unit

The regulator system should require little or no attention in normal service, and running faults resulting from such elementary causes as a slipping drive belt should be looked for before suspecting the unit. Battery conditions such as loose terminals or internal defects may also give a false impression, and are probably more likely causes of erratic electrical performance. However, if desired and subject to the comments made at the beginning of this Chapter, it is not difficult to investigate the action of the regulator and cut-out assembly. Assuming that the generator output has been found satisfactory, by testing as already detailed, the regulator can be tested using an accurate 0–20 scale voltmeter and a moving coil ammeter scale 40–0–40. Checks and adjustments must be made as quickly as possible so as to avoid errors caused by heating of the regulator coils.

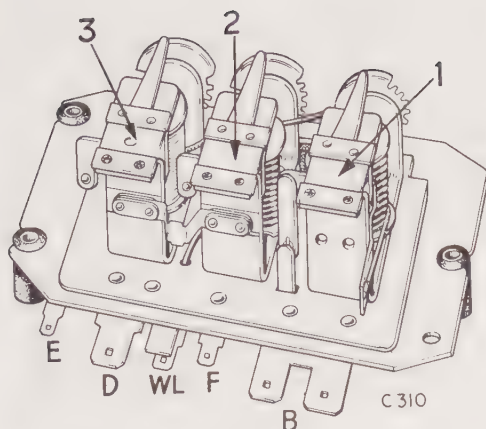


Fig 11:11 Three-bobbin type regulator unit.

Key to Fig 11:11 1 Cut-out. 2 Current regulator. 3 Voltage regulator.

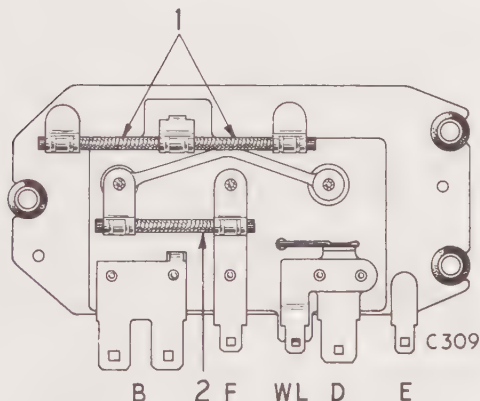


Fig 11:12 View of underside of regulator unit and terminal markings.

Key to Fig 11:12 1 Ballast resistors. 2 Field resistor.

The regulator unit is of the three-bobbin type shown on **FIGS 11:11** and **11:12**. This incorporates voltage and current regulators and cut-out. Each device can be adjusted independently by using a special tool. A wiring diagram is shown on **FIG 11:13**.

If malfunctioning is suspected the action may be investigated, but first it is essential to test the generator output as already described. If this is correct, the regulator cover should be removed and a piece of card inserted between the points of the cut-out to prevent them from closing. Connect the voltmeter between the control box terminal D and a good earth. The engine is now started and run at about 3000 rev/min. The voltmeter needle

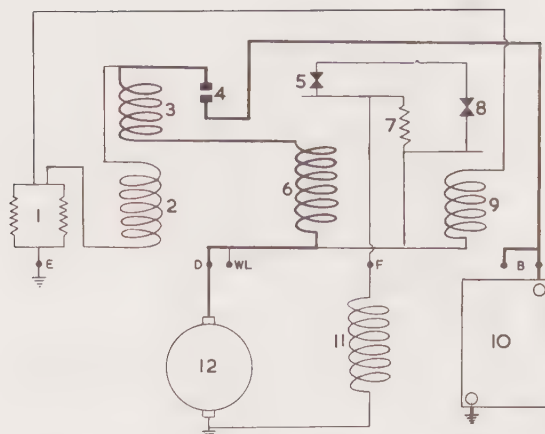


Fig 11:13 Circuit diagram of regulator unit.

Key to Fig 11:13 1 Swamp resistors. 2 Cut-out relay coil.

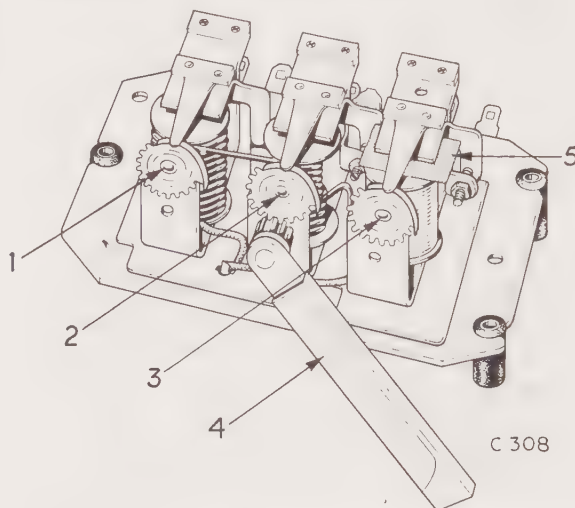


Fig 11:14 Use of special Lucas tool for adjusting regulator action by turning cam.

Key to Fig 11:14 1 Cut-out cam. 2 Current control cam. 3 Voltage control cam. 4 Tool. 5 Slip of cardboard as necessary (see text).

should give a steady reading within the limits given here, depending on the atmospheric temperature.

Ambient temperature	Voltage reading
10°C (50°F)	14.9–15.5
20°C (68°F)	14.7–15.3
30°C (86°F)	14.5–15.1
40°C (104°F)	14.3–14.9

If the reading is not within the appropriate range, the regulator needs adjusting. Gradually increase the engine speed until the maximum reading is obtained, which should not be more than 0.25 volt above the stated readings. If the reading rises with engine speed, and the needle possibly swings well over, either the regulator points are not opening or there is a fault in the earth connection

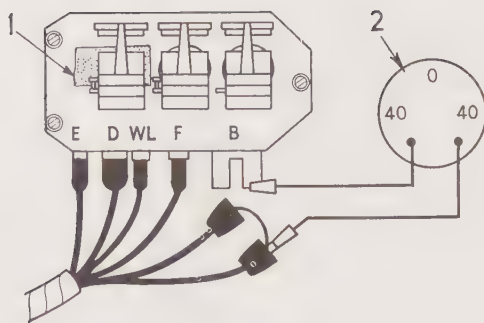


Fig 11:15 Connections of regulator for test of current setting.

Key to Fig 11:15 1 Cardboard under cut-out armature.
2 Ammeter.

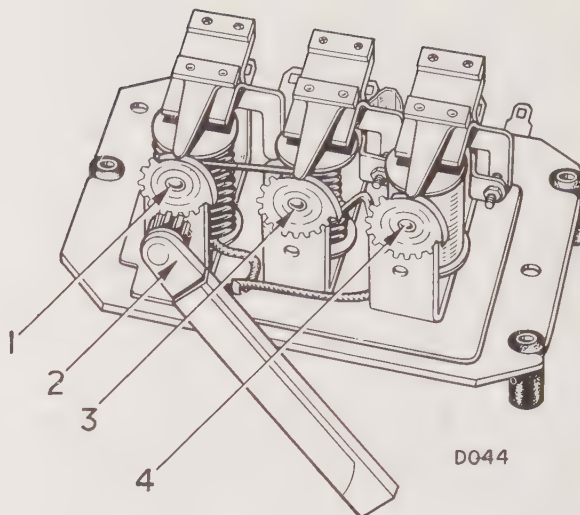


Fig 11:17 Use of Lucas tool for adjusting cut-in voltage.

Key to Fig 11:17 1 Cut-out cam. 2 Tool. 3 Current control cam.
4 Voltage control cam.

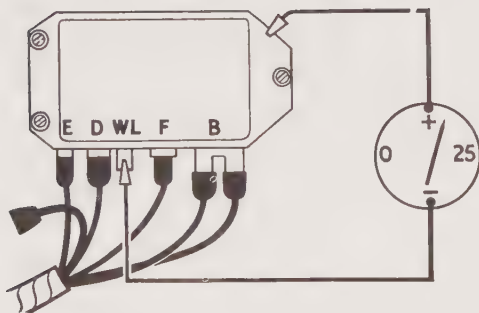


Fig 11:16 Connections of regulator for test of cut-in voltage. For negative earth, reverse meter connections.

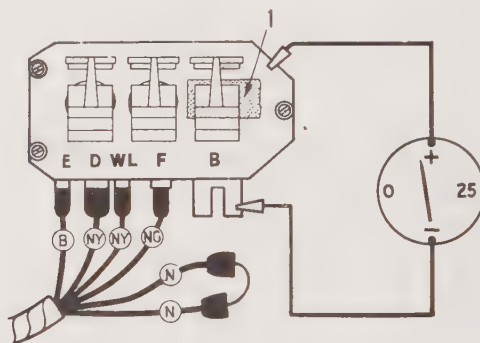


Fig 11:18 Connections of regulator for checking cut-out drop-out voltage. For negative earth, reverse meter connections.

Key to Fig 11:18 1 Cardboard under voltage regulator.

between the regulator and the body. Should the points not be opening it is likely that they are short-circuited or welded together, or that the magnet coil is faulty; the unit must then be replaced with an exchange assembly. However, if the voltmeter steadies but does so outside the range stated, the regulator can be adjusted. Stop the engine, and with the proper tool supplied by Lucas, turn the cam on the voltage regulator (see **FIG 11:14**) to obtain the correct setting. The cam is turned, clockwise, to increase and anti-clockwise to decrease the voltage. Between very small movements of the cam, start the engine and check the voltmeter reading. When all is correct, the connections may be restored.

The current regulator is set so that with all electrical equipment in use, there should be a steady reading on the

ammeter of maximum generator output at approximately 3000 rev/min, with no more than 1 amp fluctuation. This is done as follows:

Insert a piece of card between the armature and core-face of the voltage regulator to prevent the contacts opening (**FIG 11:15**). Withdraw the cables from terminal B-B, and connect them to the ammeter. Switch on all the electrical equipment and note the ammeter reading at the engine speed stated. If necessary use the special tool to adjust the current regulator (**FIG 11:14**), turning it clockwise to raise and anti-clockwise to lower, the reading. Reconnect the cables when all is correct.

11:9 Cut-out action

To check the operation of the cut-out, the headlamps

should be switched on to provide an electrical load and the voltmeter connected between terminal WL and earth (**FIG 11:16**). The engine is then started and slowly speeded up. Watch the voltmeter closely, and note the voltage reading at the point when the reading suddenly drops as the cut-out points close. This should be between 12.6 and 13.4 volts. If outside these limits, turn the adjusting cam with the special Lucas tool, clockwise to raise and anti-clockwise to lower the setting as shown on **FIG 11:17**. Do this a little at a time until the correct reading is shown.

The drop-off voltage is checked by disconnecting the cables from terminal B-B and connecting the SW terminal on the coil to the battery. Couple the voltmeter between terminal B-B and earth, as shown on **FIG 11:18**. Run the engine up to about 3000 rev/min, gradually decreasing the speed until the meter needle flicks to zero; the reading should be between 9.3 and 11.2 volts.

If the reading is outside these limits, the fixed contact height must be adjusted by carefully bending the blade, towards the bobbin to reduce, or away from the bobbin to increase the voltage; this is done with a pair of thin-nose pliers. The voltage must then be re-checked, and further adjustment made if necessary.

11:10 Setting of points

It is important that the contacts should not only meet squarely, but also have the correct gapping. To achieve this, in the case of the voltage and current regulators, turn the adjusting cam anti-clockwise to give the maximum lift of the tensioning spring. Next slacken the adjustable contact locknut and turn back the contact screw. Insert a 0.045 in feeler blade between the armature and the copper shim on the core face of the coil; care must be used to avoid damaging the shim, and the gauge pushed in as far as allowed by the two rivet heads on the armature underside. With the gauge so held, press down on the armature to trap the gauge, and screw the adjustable contact inwards until it just touches the armature contact. Then tighten the locknut, being careful not to shift the setting.

In the case of the cut-out, with the armature pressed down against the core face shim, the fixed contact must be adjusted to give 0.01 to 0.02 in deflection, or follow-through movement. The armature is then released and the backstop adjusted to give a core to armature gap of 0.035 to 0.045 in (**FIG 11:19**). After the gaps have been adjusted, it is necessary to check the electrical settings as already described.

Regulator contacts can be trued if necessary with a fine carborundum stone or silicon carbide paper. The contacts are then cleaned with methylated spirits. The contacts on the cut-out are dealt with differently, and it is essential that no carborundum or emery cloth is used here, as the contacts are of soft metal. The correct method is with a strip of fine glasspaper. Before attempting to clean regulator contacts, the wiring must be disconnected and the complete regulator removed from the car. The adjustable contacts can then be taken off, which will facilitate cleaning of all the contacts.

11:11 Windscreen wiper

The wiper mechanism is shown on **FIG 11:20**. The only normal requirement to keep this in good order, is to

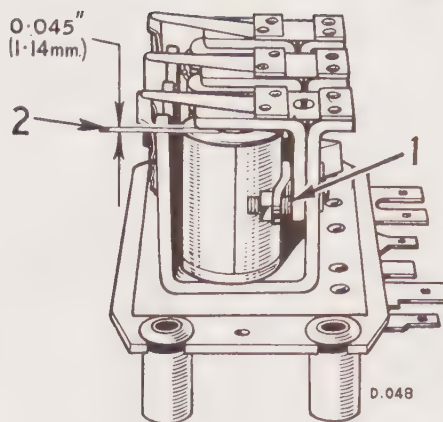


FIG 11:19 Air-gap setting of cut-out.

Key to FIG 11:19 1 Backstop adjustment. 2 Air gap setting.

renew the blades when necessary. If the driving motor is faulty it may be removed complete with the inner cable rack. The wiper arms with their blades should first be pulled off their milled bosses. Unscrew the nut securing the cable conduit to the motor and gearbox. The latter can then be taken off, after taking out the three bolts which secure it to the dash panel.

The brushes can be inspected by removing the cover from the end of the motor remote from the gearbox. Check that the brushes are bearing freely on the commutator, and replace the tension spring if this has weakened. The brush levers can be freed if stiff on their pivots, by working them with the fingers while applying a smear of thin oil. Worn brushes must be replaced.

The push-pull motion transmitted to the flexible rack must be quite smooth in operation. If there is any sluggishness, smear a little grease (Ragazine Listate or similar) in the guide channel of the housing. Ensure also that all pivots and gears are lightly greased.

If attention on these lines does not give satisfactory operation, the unit should be exchanged.

11:12 The horn

The horns are of the diaphragm type, adjusted as to quality and loudness before leaving the factory; thus no attention is required until after a long period of service. If any trouble is experienced under any conditions, it is essential that the horn is not dismantled other than as covered by the following information. If this does not enable correct operation to be restored, an exchange unit should be fitted.

If the horn fails after normal working, this is most likely due to a faulty connection in the circuit. Erratic performance can be the result of loose mountings or terminals, or of course a discharged battery. If all these are in order, it is possible to adjust the horn itself. The horn should be removed and clamped securely in a vice so as to obtain a good tone. At the rear adjacent to the terminals, and as shown on **FIG 11:21**, is an adjustment screw which may be either plain or serrated. This is rotated in an anti-clockwise direction until the horn just fails to sound when

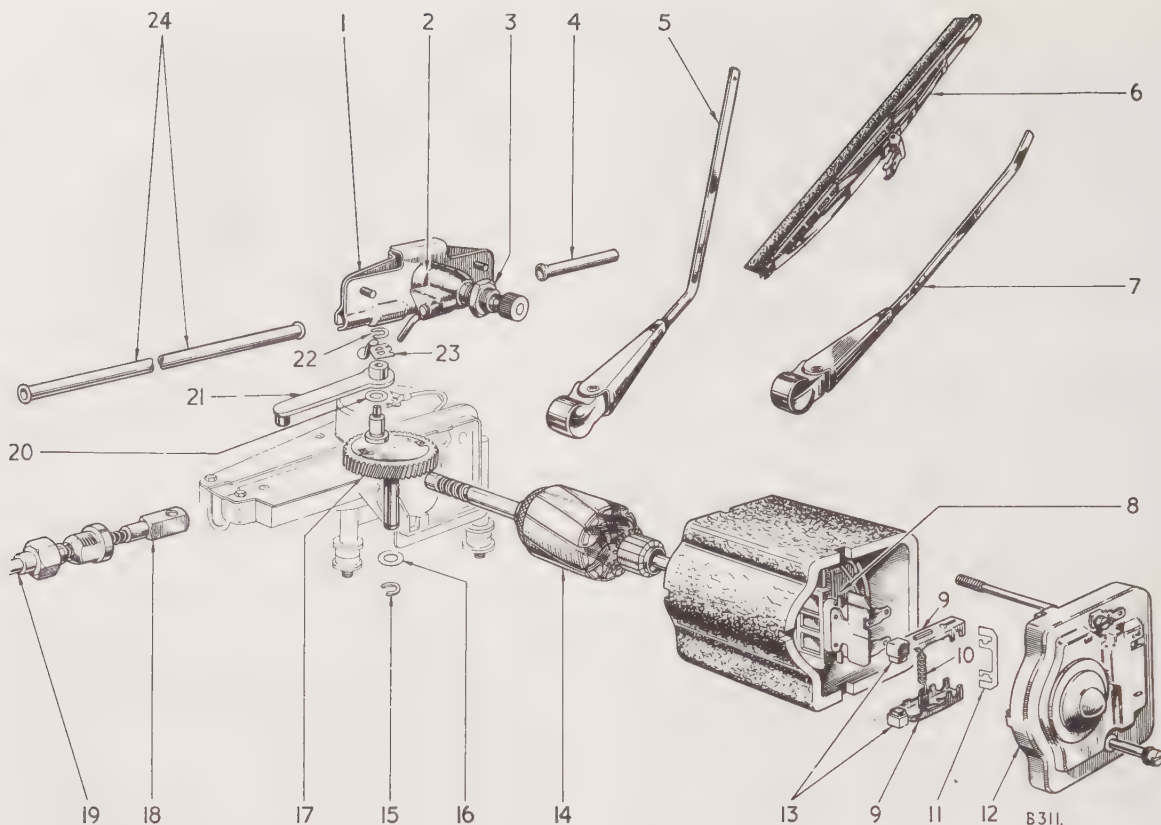


Fig 11:20 Components of windscreen wiper system.

Key to Fig 11:20 1 Wheel box. 2 Jet and bush assembly. 3 Nut. 4 Rigid tubing—right-hand side. 5 Wiper arm. 6 Blade. 7 Wiper arm. 8 Field coil assembly. 9 Brushgear. 10 Tension spring and retainers. 11 Brushgear retainer. 12 End cover. 13 Brushes. 14 Armature. 15 Circlip. 16 Washer. 17 Final drive wheel. 18 Cable rack. 19 Rigid tubing—left-hand side. 20 Spacer. 21 Connecting rod. 22 Circlip. 23 Parking switch contact. 24 Rigid tubing—centre section.

connected to a 12-volt battery; the screw is then turned one-quarter turn clockwise to obtain maximum effect. It should be emphasized that the adjustment compensates for wear only, and should not alter the tone, which is 'fixed'.

An alternative method using an ammeter, is to connect this in series with the battery and horn, and rotate the adjusting screw until a current reading within the limits of 3 to 3.5 amp is obtained, when all should be correct. The screw and locknut at the centre of the cover must not be disturbed.

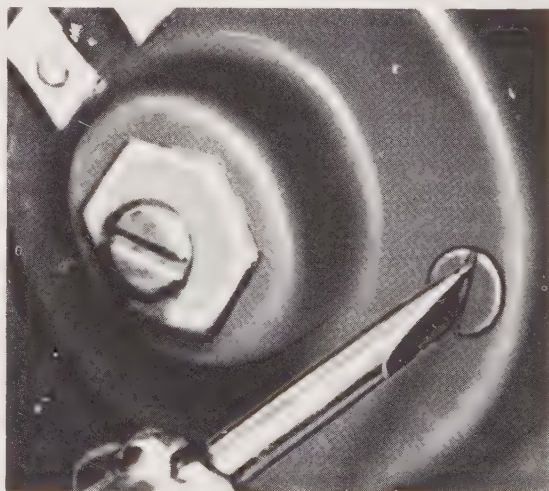


Fig 11:21 Method of adjusting horn.

11:13 Fault diagnosis

(a) Battery discharged

- 1 Terminals loose or dirty
- 2 Lighting circuit short-circuited
- 3 Generator not charging
- 4 Regulator or cut-out units not working properly
- 5 Battery internally defective

(b) Insufficient charging current

- 1 Loose or corroded battery terminals
- 2 Generator driving belt slipping

(c) Battery will not hold a charge

- 1 Low electrolyte level
- 2 Battery plates sulphated
- 3 Electrolyte leakage from cracked casing or top
- 4 Plate separators ineffective

(d) Battery overcharged

- 1 Voltage regulator needs adjusting

(e) Generator output low or nil

- 1 Belt broken or slipping
- 2 Regulator unit out of adjustment
- 3 Commutator worn, burned or short-circuited
- 4 Insulation proud between commutator segments
- 5 Brushes sticking, springs weak or broken
- 6 Field coil wires short-circuited, broken or burned

(f) Starter motor lacks power or will not operate

- 1 Battery discharged, loose cable connections
- 2 Starter pinion jammed in mesh with flywheel gear
- 3 Starter switch faulty
- 4 Brushes worn or sticking, leads detached or short-circuiting
- 5 Commutator dirty or worn
- 6 Starter shaft bent
- 7 Engine abnormally stiff

(g) Starter motor runs but does not turn engine

- 1 Pinion sticking on screwed sleeve
- 2 Broken teeth on pinion or flywheel gears

(h) Noisy starter pinion when engine is running

- 1 Restraining spring weak or broken

(j) Starter motor inoperative

- 1 Check 1 and 4 in (f)
- 2 Armature or field coils faulty

(k) Starter motor rough or noisy

- 1 Mounting bolts loose
- 2 Damaged pinion or flywheel gear teeth
- 3 Main pinion spring broken

(l) Lamps inoperative or erratic

- 1 Battery low, bulbs burned out
- 2 Faulty earthing of lamps or battery
- 3 Lighting switch faulty, loose or broken wiring connections

(m) Wiper motor sluggish, taking high current

- 1 Faulty armature
- 2 Bearings out of alignment
- 3 Commutator dirty or short-circuited
- 4 Wheelbox spindle binding, cable rack tight in housing

(n) Wiper motor operates but does not drive arms

- 1 Wheelbox gear and spindle worn
- 2 Cable rack faulty
- 3 Gearbox components worn

(o) Panel gauge does not register

- 1 No battery supply to gauge.
- 2 Gauge casing not earthed
- 3 Cable between gauge and sender unit earthed

CHAPTER 12

BODYWORK

- 12:1 Door locks**
- 12:2 Remote control**
- 12:3 Adjustment**
- 12:4 Window winder mechanism**
- 12:5 Heater unit**
- 12:6 'Spitfire' heater**

- 12:7 Instruments and switches**
- 12:8 Panel controls**
- 12:9 Extra instruments**
- 12:10 Fuel tank**
- 12:11 Lamp and bulbs**

Because of the very specialized form of modern body construction, it is usually necessary to take the car to an agent with a properly equipped body-shop, if any exacting work such as replacement of glass, re-hanging of doors, panel-beating, etc., is called for. However, it will be useful to detail some minor items which may call for attention, and which do not require the use of special tools nor any expertness other than reasonable care. It is obviously necessary in work of this kind, to avoid slips with sharp-edged tools which are likely to prove more damaging to soft materials and furnishings than robust metal.

12:1 Door locks

If removal of a door lock is required (for repair or replacement), first refer carefully to **FIG 12:1**, for clarification of parts. It is necessary first to take off the trim panel from the door interior; this in turn requires the removal of the interior handles. To do this, the escutcheon of the remote control lock handle is pressed back firmly against the trim panel, using a screwdriver with a broad blade. This exposes the retaining pin of the handle, and if this is pushed out (**FIG 12:2**), the handle and escutcheon can be pulled off the spindle. The window winding handle is dealt with in a similar manner.

The wooden cappings and pull-handles are next removed by taking out the screws. The trim panel is held by clips, and by inserting a screwdriver between the panel and door, and gently levering the retaining springs away from the door frame, as shown on **FIG 12:3**, the whole panel can be eased off without damage. The coil springs are then taken off the lock and winder spindles.

When replacing the panel, first fit the springs to the spindles, noting that the stouter spring goes on the window winder. The springs are also fitted with the small-coil end against the door frame. Fit the trim panel over the spindles, and secure it evenly and neatly by pressing the retaining springs into the holes in the door panel. To refit the handles, place the escutcheon and handle on the spindle, with the latter correctly positioned. Press the handle inwards until the holes for the cross-pin (in the handle and spindle) line-up. Work the pin into position by pushing the escutcheon further in, and insert the pin completely. The escutcheon will then come forward, to cover the junction and pin.

A door lock and control mechanism is shown on **FIG 12:4**. To remove a door lock (**FIG 12:5**) the window is first raised and the three screws taken out of the rear channel; lower the channel to the door bottom. Put the handle on the lock spindle, move it to the open position, and secure it in this position by inserting a pin through the hole just below and to the left of the spindle. Referring to **FIG 12:4** remove the circlip and washer connecting the pivot pin of the remote control link to the lever, and uncouple the link. Take out the four screws which secure the lock and dovetail plate to the door. Next press the lock inwards and down, until the latch and push-button can be passed inside the door. Turn the lock body so that the latch mechanism is underneath, and the side of the lock is between the window support channel and the lower edge of the small aperture in the door panel. The lock can then be moved downwards, and taken out through the large aperture. When replacing the lock, first

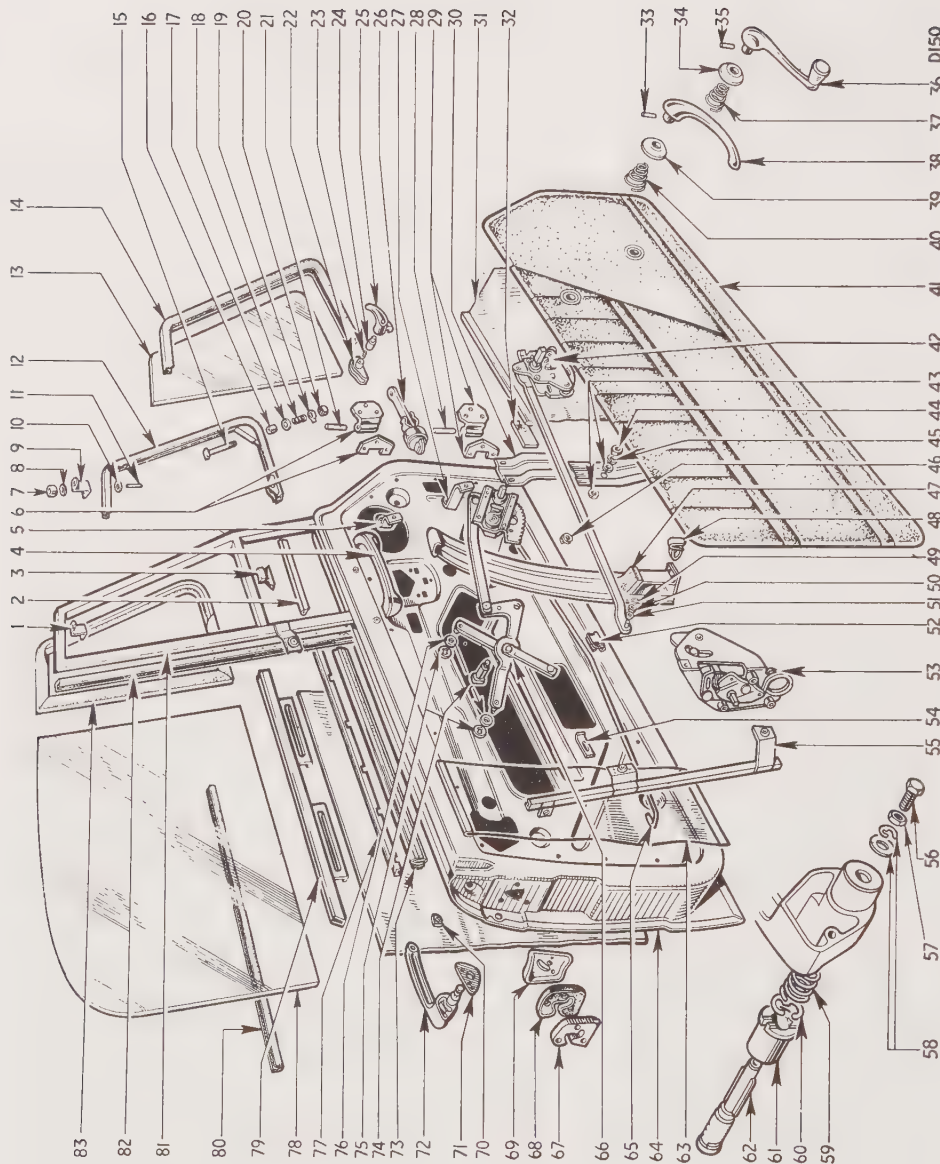


Fig 12:1 Components of door assembly, 'Vitesse'.

- Key to Fig 12:1**
- | | | | | | | | | | | | |
|---------------------|------------------|---------------------|-------------------|------------------|--------------------|---------------------|--------------------|----------------|----------------|-------------------|---------------------|
| 1 Ventilator hinge. | 2 Finisher. | 3 Plate. | 4 Pull handle. | 5 Bracket. | 6 Hinge. | 7 Spacer. | 8 Washer. | 9 Hinge. | 10 Washer. | 11 Rivet. | 12 Frame. |
| 13 Glass. | 14 Weatherstrip. | 15 Pivot. | 16 Spring. | 17 Washer. | 18 Spring. | 19 Lockwasher. | 20 Nut. | 21 Hinge pin. | 22 Lock. | 23 Spring. | 24 Pivot. |
| 25 Handle. | 26 Check arm. | 27 Bracket. | 28 Hinge pin. | 29 Hinge. | 30 Reinforcement. | 31 Deflector panel. | 32 Pad. | 33 Pin. | 34 Escutcheon. | 35 Pin. | 36 Handle. |
| 37 Spring. | 38 Handle. | 39 Escutcheon. | 40 Spring. | 41 Trim pad. | 42 Remote control. | 43 Washers. | 44 Nut. | 45 Washer. | 46 Washer. | 47 Reinforcement. | 48 Clip. |
| 49 Clip. | 50 Washer. | 51 Washer. | 52 Clip. | 53 Lock. | 54 Bracket. | 55 Run channel. | 56 Bolt. | 57 Nut. | 58 Washers. | 59 Spring. | 60 Washer. |
| 61 Push button. | 62 Lock barrel. | 63 Deflector panel. | 64 Door assembly. | 65 Restrainer. | 66 Regulator. | 67 Striker. | 68 Sealing rubber. | 69 Lock cam. | 70 Gasket. | 71 Gasket. | 72 Exterior handle. |
| 73 Weatherstrip. | 74 Pivot. | 75 Clip. | 76 Washers. | 77 Weatherstrip. | 78 Glass. | 79 Channel. | 80 Weatherstrip. | 81 Ventilator. | 82 Felt. | 83 Weatherstrip. | |

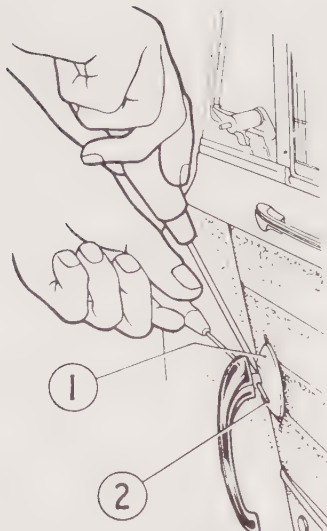


Fig 12:2 Method of removing interior handles.

Key to Fig 12:2 1 Escutcheon. 2 Cross-pin in spindle.



Fig 12:3 Removal of trim panel.

insert it into the door with the latch mechanism towards the door inner panel and the push-button pointing downwards. Now push the lock upwards, and turn the body until the push-button is compressed against the door outer panel and the latch is underneath. The side of the lock will now be between the window support channel and the lower edge of the small aperture in the door panel. Continue to push the lock upwards until it comes clear of the support channel; it can then be turned into its correct

position, with the latch and push-buttons protruding through their respective openings in the door.

The dovetail plate is then fitted, and the three screws inserted and tightened. When replacing the channel for the window glass, fit this loosely on the screws and then tighten the upper screws. Lower the window and adjust the channel until the glass can slide freely without excessive side movement. The remaining screws can then be tightened.

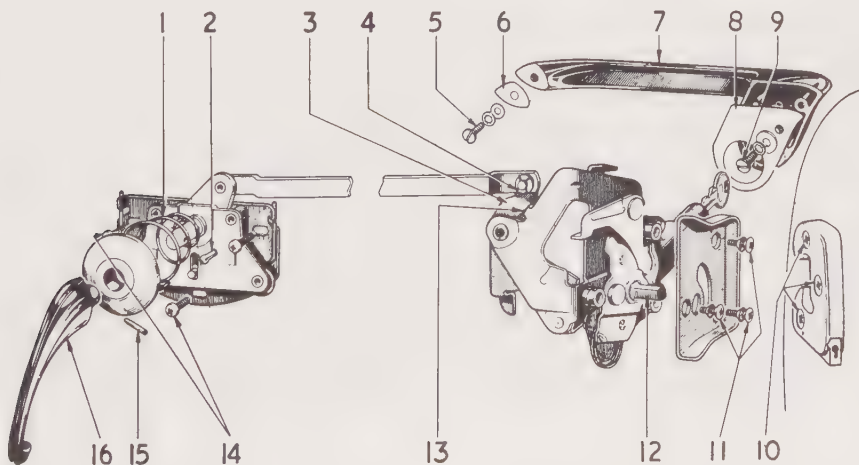


Fig 12:4 Components of door lock and remote control.

Key to Fig 12:4 1 Control mechanism. 2 Pin in locked condition. 3 Lock lever. 4 Spring clip. 5 Screw. 6 Packing

piece. 7 Exterior handle. 8 Packing piece. 9 Screw. 10 Striker securing screws. 11 Lock securing screws. 12 Lock lever. 13 Lock stop. 14 Remote control securing screws. 15 Pin. 16 Interior handle.

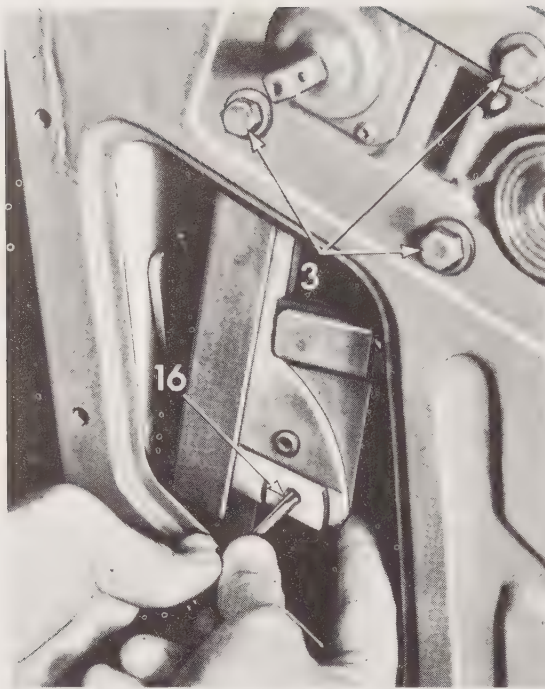


Fig 12:5 Removal of door lock (lowering of glass channel).

Key to Fig 12:5 3 Fixing screws. 16 Glass guide.

12:2 Remote control

The lock remote control mechanism, shown on **FIGS 12:6 and 12:7**, can be removed without disturbing either the lock itself or the window. The handle is first moved to the open position, and held thus by inserting the restraining pin in the lock body as already described. The circlip and washer are then taken off as before, and also the three screws holding the remote control to the door. The mechanism can then be removed, as shown on **FIG 12:8**.

When refitting the remote control, the restraint pin is first inserted in the lock, and the control placed in position and loosely held by the screws. The link is then connected temporarily to the lock lever by its pivot pin. Move the remote control towards the lock until the lock lever is contacting its stop, and then tighten the securing screws of the remote control. Next remove the lock retaining pin, move the handle into the open position, and replace the pin. The link must now be disconnected, the waved washer fitted to the link-pin and the link coupled permanently to the lock lever by means of the circlip. Remove the retaining pin from the lock.

All moving parts of the lock and control should be lightly greased, and after fitting, a few drops of thin oil may be put into the latch and key slots, and the surplus wiped off; never use grease on the lock cylinder.

12:3 Adjustment

The lock striker plate is secured to the doorpost by means of three screws which allow of some adjustment. The correct position must be obtained by trial and error, the object being an easy closing action, with freedom from lift, fall or rattle as essential requirements. Finally, the plate must be in the horizontal plane in relation to the axis of door movement, and the screws fully tightened.

Removal of the locks and remote control on Convertible bodied cars follows the same lines as the following, the minor detail differences will not affect the general instructions. The door hinge attachments are shown on **FIG 12:9**.

12:4 Window winder mechanism

If trouble is experienced with a window winder, a replacement mechanism should be fitted. Access is obtained by removing the handles and trim as before. Referring to **FIG 12:1**, remove the spring clips and leather washers (items 75 and 76 on the drawing), and spring the arms so as to be clear of the channel. The glass must then be lifted to its highest point. Remove the nut and spring washers holding the regulator pivot to the inner panel. Take off the pivot and the double-coil washer which is located between the inner panel and the regulator.

Remove the four screws securing the inner panel reinforcement from the door. Take out the five screws (one located in the door edge) which secure the ventilator unit, and lift the unit about 2 in (50 mm). Note that the channel tension wire is held by the lowest of these screws. The four screws attaching the winder mechanism to the door may now be taken out, the assembly passed into the door casing, and removed via the large aperture in the panel. Replacement is a reversal of the foregoing; all moving parts should be lightly greased.

12:5 Heater unit

Two types of heater are shown on **FIGS 12:10 and 12:11**. Before removal, the cooling system must be drained, the heater hose connections uncoupled, and the electrical leads disconnected from the motor; it is advisable also to isolate the battery by removing its main leads. Release the control cables from the heater water valve, and take out the screw from the bracket to the dash panel at the heater centre. From inside the car uncouple the air distribution control cables from the distribution valve (**FIG 12:10**). Remove the six screws holding the trim panel under the dashboard. Disconnect the demister hoses from the air distribution box, and remove the two nuts holding the box to the heater unit. The heater and air box can then be taken off.

When replacing the heater, first remove all the old sealing compound, and liberally coat the areas of contact with a good jointing such as Seelastik. These are the areas between the heater, gasket and dash panel. The heater is then positioned on the panel with the gasket adhering to the heater base, and the bracket at the top centre secured with the screw. Fit the air distribution box to the heater studs, and screw on the nuts. The demister hoses and control cables are then replaced.

The controls are adjusted as when looking from the right-hand side of the car. Push the dashboard knobs fully in, and slacken the trunnions which secure the inner cables. Take any slack out of the cables, and tighten the

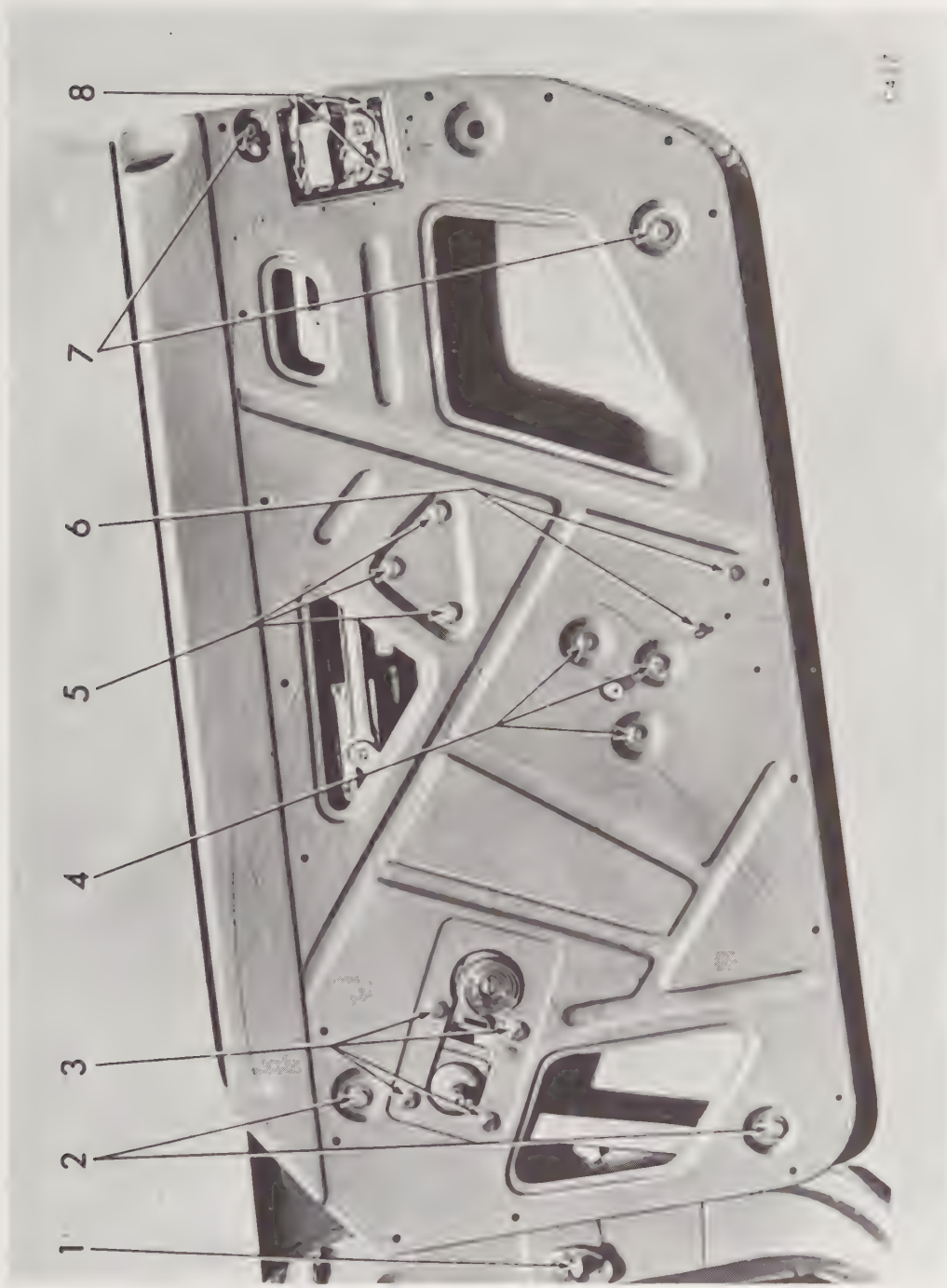


Fig 12:6 Inner door panel ('Spitfire') with trim removed. Other types are generally similar.

Key to Fig 12:6 1 Check arm. 2 Glass channel screws. 3 Regulator screws. 4 Remote control screws. 5 Regulator pivot screws. 6 Bottom stop screws. 7 Glass channel screws. 8 Lock.

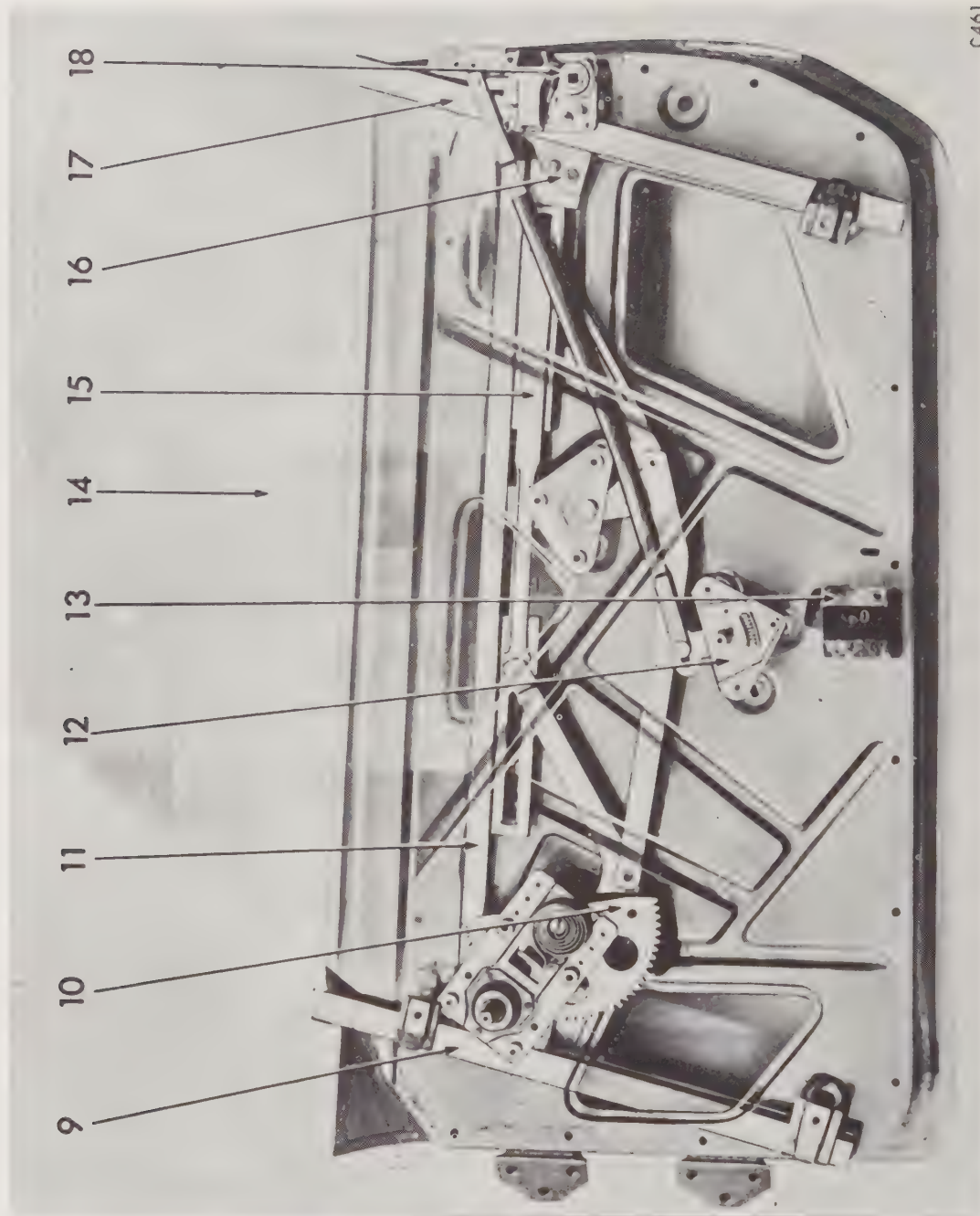


Fig 12:7 Layout of components inside door ('Spitfire'). Other types are generally similar.

Key to Fig 12:7 9 Glass channel. 10 Regulator mechanism. 11 Operating channel. 12 Remote control mechanism.
13 Bottom stop. 14 Glass. 15 Interconnecting link. 16 Guide packing. 17 Run channel. 18 Lock.

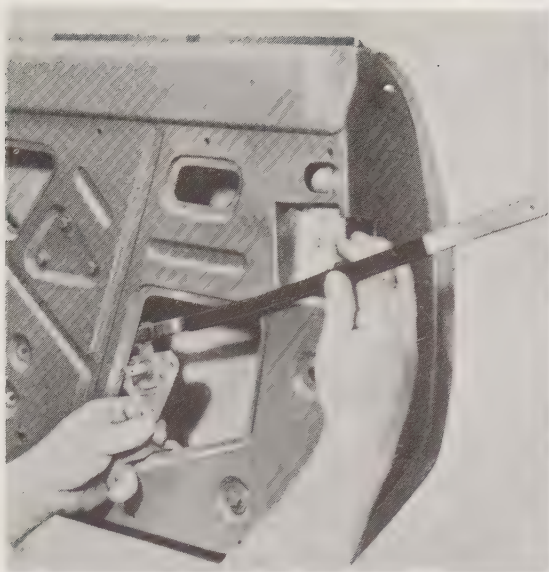


Fig 12:8 Removal of remote control and connecting link, from inside of door



Fig 12:9 Attachments at door hinge

Key to Fig 12:9 1 Bonnet stop bracket. 2 Bolts, hinge to scuttle. 3 Bolts, hinge to door. 4 Bonnet fastener bracket

trunnions. Next turn the air distribution control anti-clockwise to its full extent, and check that both the controls operate correctly. Refit the trim panel.

The electrical system can then be connected up, the hoses refitted and the cooling system filled. Check for correct action, and water leaks, with the engine running.

12:6 'Spitfire' heater

If the heater shown on **FIG 12:11** is fitted to a car not previously equipped, the details must be followed carefully. First the battery must be disconnected and the cooling system drained. Remove the square-headed plug from the water-pump rear, and screw the adaptor supplied, into the hole after applying sealing compound to the threads. Remove the rear cylinder head nut from the right-hand side of the engine.

Referring to **FIG 12:11**, the nut 22 and olive 21 are assembled to the water pipe 23. The pipe is then passed under the manifold, and connected to the adaptor on the pump. The bracket on the rear end of the pipe is fitted over the cylinder head stud and the nut refitted and tightened to the correct torque (Chapter 1).

The square-headed plug is unscrewed from the rear of the cylinder head, and the adaptor 19 screwed into the hole after applying sealing compound to its threads. Assemble the water valve 17 to the bracket 16 and attach hoses 24 and 14. Now take off the screws which secure the ignition coil, apply sealing compound to the underside of bracket 16, and fit this bracket between the coil mounting and the bulkhead. From inside the car, identify a circular blanking plate underneath the dash panel, take out its four screws, and remove the plate. Attach the demister hoses 2 to the heater unit 4. Now remove the nuts securing the finishers 10 to the top of the dash, and fit the demister outlet nozzles 1, to the underside, with the same nuts.

Next identify and remove six rubber blanking plugs from the engine side of the dash panel. They are situated two on each side of the plenum chamber, one at the rear edge of the ignition coil, and one on the left of the windscreen washer container. The sealing rubbers 26 are now assembled to the heater unit 4, and the ring 13 is liberally coated with sealing compound. With the four bolts and eight washers provided, secure the heater unit to the dash panel. Fit the motor earthing cable between the heater unit and dash panel, at the lower bolt on the passenger side of the car.

The hoses 14 and 25 are connected to the heater unit by use of a long screwdriver. The opposite end of 25 is connected to water pipe 23, and the free end of 24 to the adaptor 19. The demister hoses 2 are attached to the nozzles 1. Take out the two blanking plugs from the switch panel and fit the switch in the centre position, with the 'on' position nearest to the steering wheel.

The spare green cable in the cable harness loom is connected to the straight switch terminal, and the cable from the blower to the angled switch terminal.

The end of the heat control cable 5 is then passed through the dash panel, via the same grommet as the windscreen washer tubing, and the control fitted to the switch panel. Push the control cable 5 fully 'in', and assemble it to the water valve. Turn the valve to 'off' and tighten the trunnion nut.

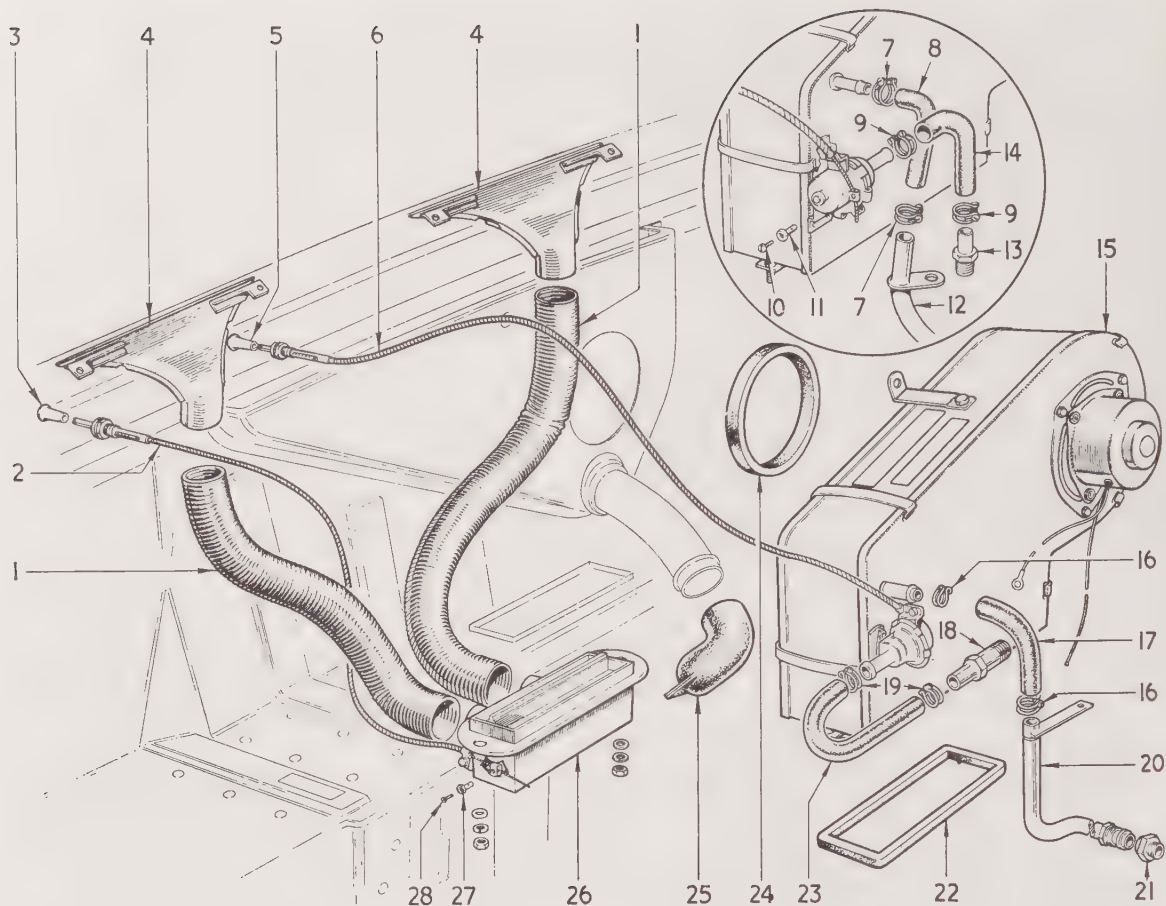


Fig 12:10 Components of heating system.

Key to Fig 12:10 1 Demister hose. 2 Air distribution control cable. 3 Control knob. 4 Demister nozzle. 5 Control knob. 6 Heat control cable. 7 Hose clip. 8 Hose. 9 Hose clip. 10 Screw. 11 Trunnion. 12 Water pipe. 13 Adaptor. 14 Hose. 15 Heater unit. 16 Hose clip. 17 Hose. 18 Adaptor. 19 Hose clip. 20 Water pipe. 21 Adaptor. 22 Seal. 23 Hose. 24 Seal. 25 Plenum drain. 26 Air distribution box. 27 Trunnion. 28 Screw.

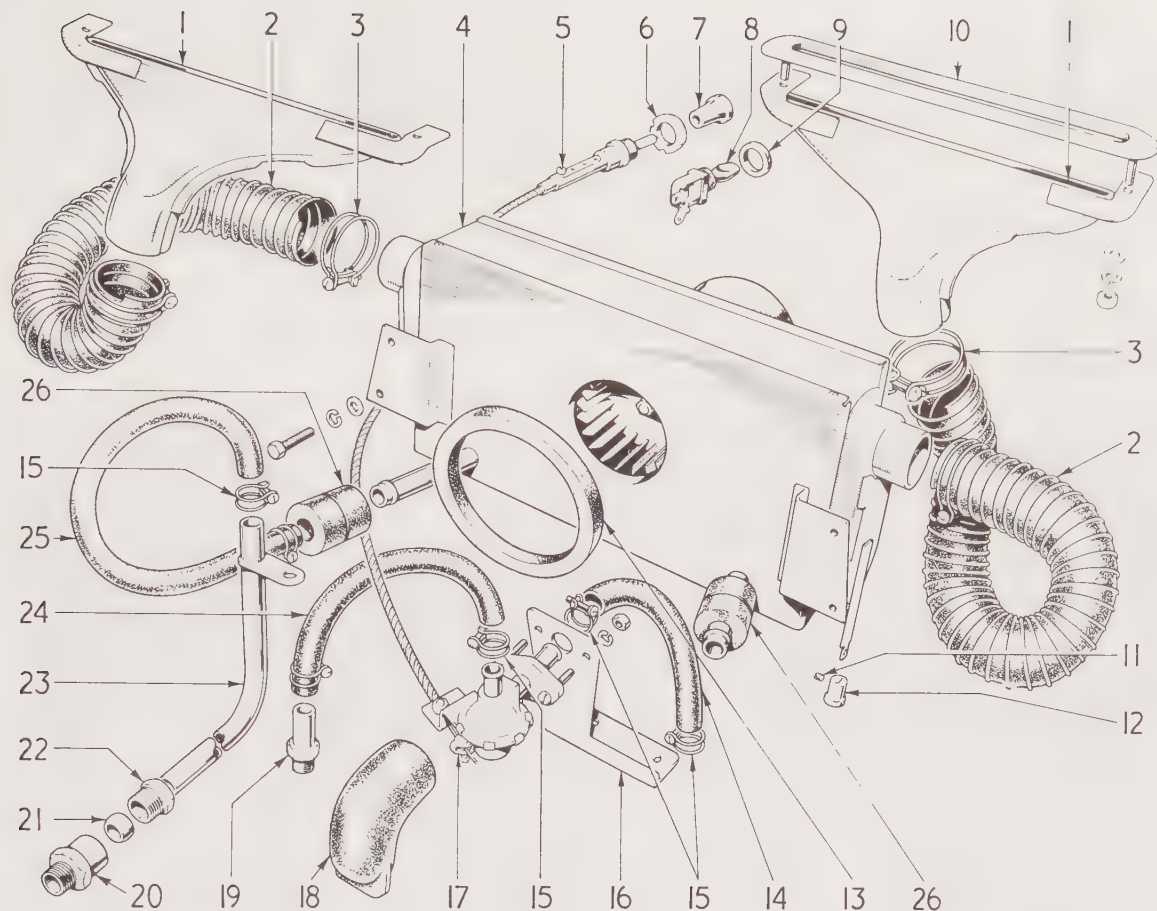


Fig 12:11 Components of heating system as available for earlier 'Spitfire' cars.

Key to Fig 12:11 1 Demister nozzle. 2 Air hose. 3 Clip. 4 Heater unit. 5 Heat control. 6 Bezel. 7 Knob. 8 Switch. 9 Bezel. 10 Finisher. 11 Screw. 12 Knob. 13 Sealing ring. 14 Clip. 15 Bracket. 16 Water hose. 17 Valve. 18 Plenum drain. 19 Adaptor. 20 Adaptor. 21 Olive. 22 Nut. 23 Water pipe. 24 Water hose. 25 Water hose. 26 Rubber seals.

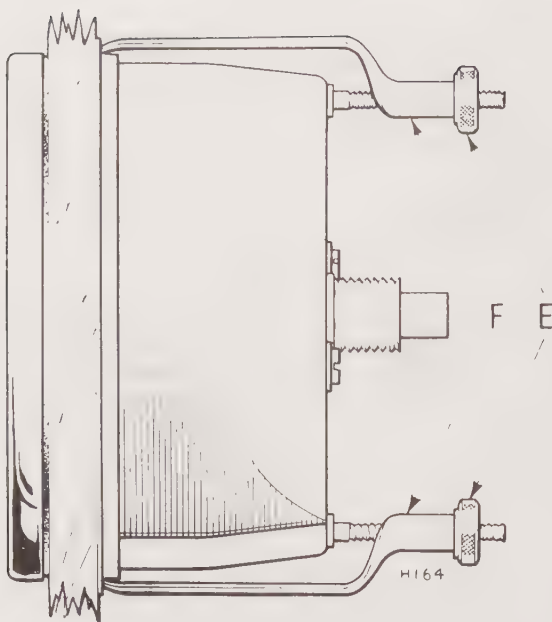


Fig 12:12 Mounting of speedometer and revolution indicator (for E and F refer to text).

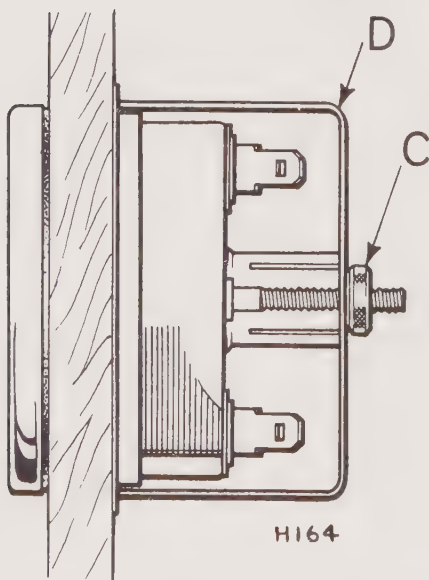


Fig 12:13 Electrically-operated gauge (for C and D refer to text).

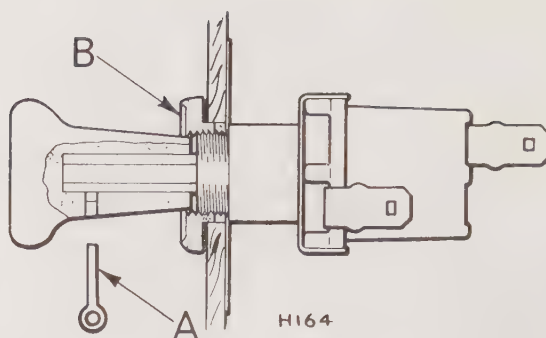


Fig 12:14 Arrangement of switch (for A and B refer to text).

The cooling system may then be refilled, and the system checked with the engine running, for correct operation and absence of leaks. It is advisable to tighten the hose connections after a short period of running.

12:7 Instruments and switches

It will be useful to describe the procedure for removing and refitting various instruments and switches. Details may vary according to the type of car, but the following information will be found generally applicable.

Before commencing work of this kind it is most important to isolate the electrical system by disconnecting the main battery lead.

To remove a speedometer or revolution indicator (**FIG 12:12**) first uncouple the drive cable, and pull out the light bulb holders. Disconnect the leads to the voltage stabilizer at the Lucar connectors, and also the flexible trip reset cable (speedometer). Unscrew the two knurled nuts shown at 'E'. Take off the earth lead or leads, and remove the clamps 'F'. The instrument can then be pushed out through the front of the panel, the reinforcing ring being taken away from the rear at the same time.

To refit, check that the rubber ring is in good condition, locate it adjacent to the meter rim, and insert the unit into the panel aperture. Fit the reinforcing ring from behind, followed by the clamps 'F', earth leads, washers, and nuts 'E'. Reconnect the voltage stabilizer, couple up the trip reset cable, and insert the bulb holders. The drive cable may then be connected.

Electrically-operated gauges such as those for fuel content and water temperature are removed by uncoupling the Lucar connectors at the rear, and detaching the light bulb holders. Unscrew the single knurled nut shown at 'C' on **FIG 12:13** and remove the spring washer, clamp 'D' and earth lead. The gauge is then pushed through the panel as before, taking off the rear reinforcing ring simultaneously. To refit, check the rubber ring, position it adjacent to the rim, mount the gauge in the panel, and refit the reinforcing ring, clamp 'D', earth lead, washer, and nut. Refit the bulb holder, and reconnect the Lucar connectors. Lighting switches of the type shown on **FIG 12:14** are removed by first inserting a pin as shown at 'A' into the hole in the knob, which depresses a spring plunger locating the knob, and allows it to be pulled off. The bezel ring 'B' can then be unscrewed.

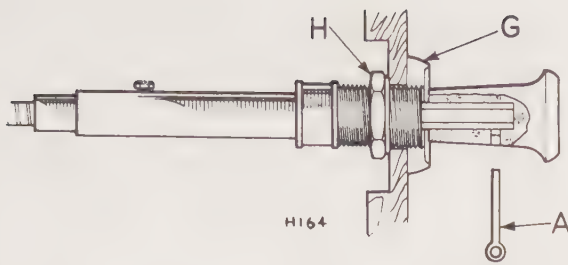


Fig 12:15 Typical push-pull panel control (for A, G and H refer to text).

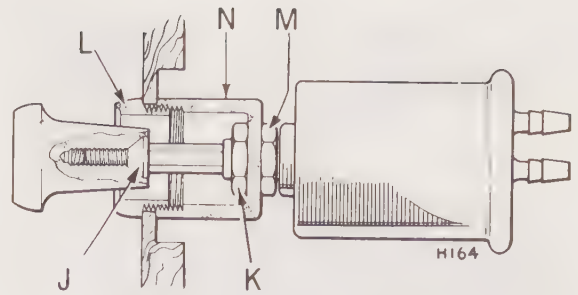


Fig 12:16 Windscreen washer pump. (For lettering refer to text)

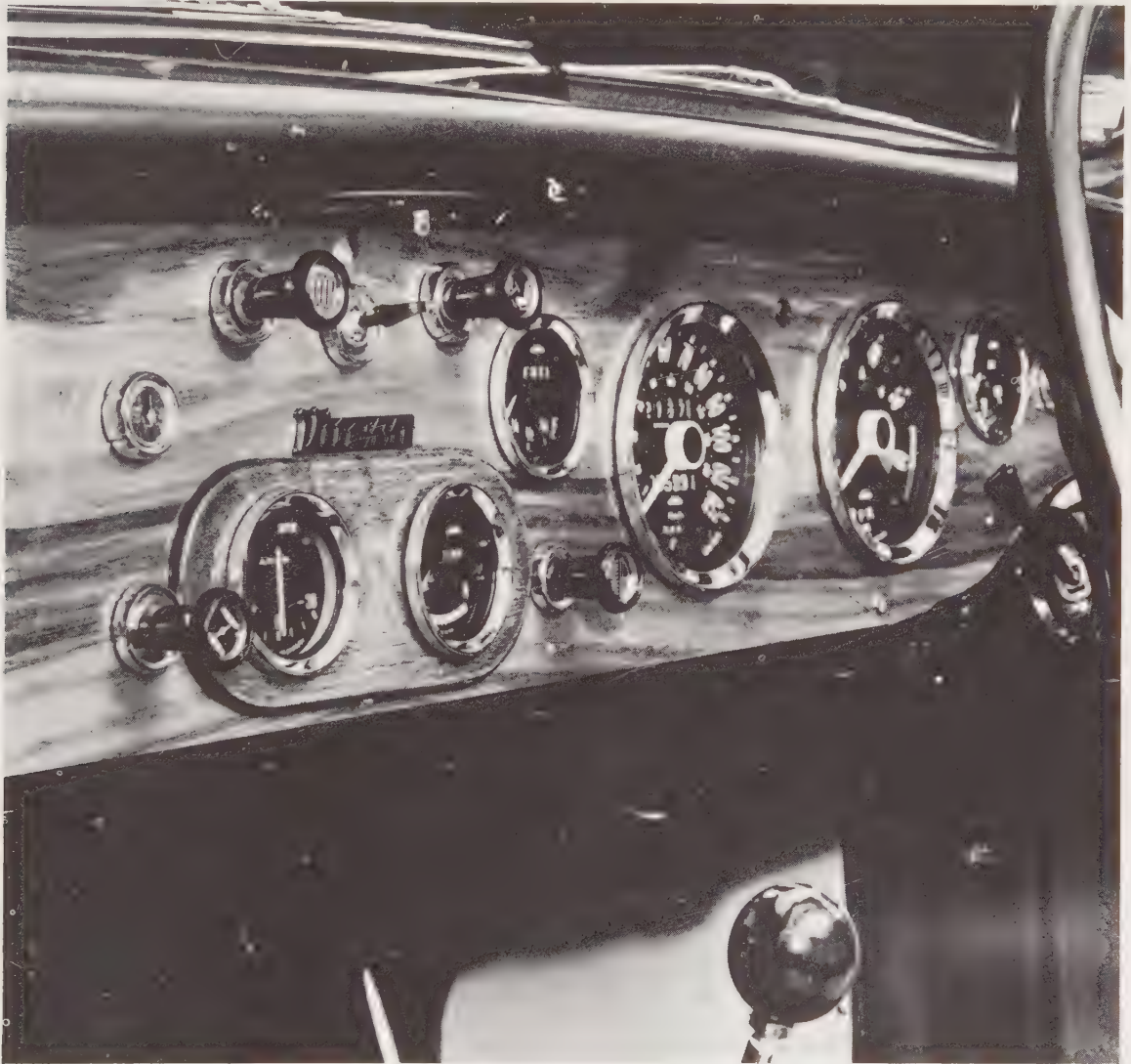


Fig 12:17 Panel of 'Vitesse' 2-litre, showing additional instruments accommodated in place of ashtray at centre.

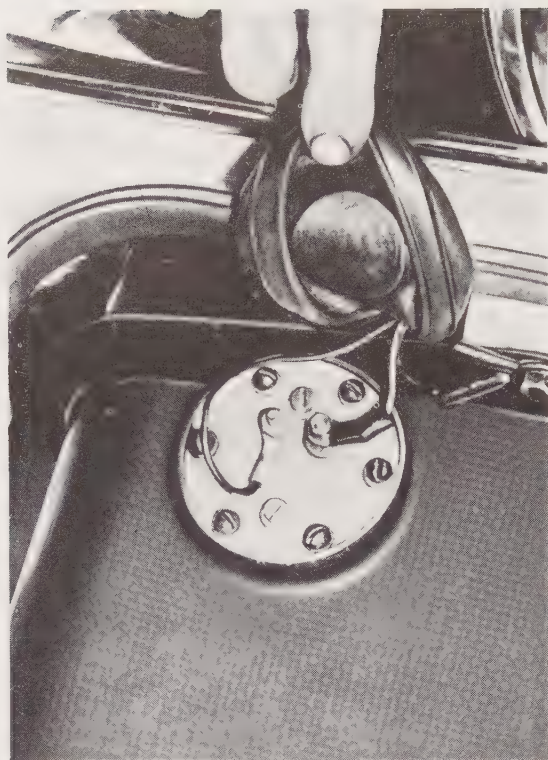


Fig 12:18 Fuel gauge tank unit, showing position of coloured connections to terminals

The Lucar connectors are then detached and the switch withdrawn from the back of the panel. When refitting, it is only necessary after securing the switch in the panel to push on the knob, when the spring-loaded pin will click into position to hold it. The ignition and starter switch, without a knob, is otherwise dealt with similarly.

As an increased safety factor, certain cars are now fitted with recessed switches and other fittings which avoid undue protrusion from the panel surface. Such modifications do not however, affect the general requirements for removal.

12:8 Panel controls

Panel controls of the type shown on **FIG 12:15** have their knobs secured by a spring plunger of the type just described, and after releasing this by means of a pin A the bezel G can be unscrewed. Detach the complete cable and casing from its control function at the other end, and withdraw. When refitting, position the control with the spring plunger lowermost, screw on the bezel G and tighten the nut H securely. Push on the knob, which will click into position. It is desirable to make sure that the identification diagrams on the knobs are correctly

presented, and if necessary the control must be rotated in the panel before finally tightening the nut.

The manually-operated windscreen washer pump is shown on **FIG 12:16**. To remove this, unscrew the knob and collar J and detach the two pipes from the rear of the barrel. The nut K is then unscrewed and the barrel and plunger detached from the rear of the panel. The mounting can be taken off the panel by unscrewing the bezel L.

12:9 Extra instruments

For 'Vitesse' owners who do not require the central ashtray, the aperture left by removal of this item forms a very convenient method of fitting two extra instrument dials, such as ammeter and oil-pressure gauge, of the type listed by the car manufacturers. The rectangular hole will require shaping to take the instrument bodies, and a wooden base should be made having a polished finish to match the dashboard, as shown on **FIG 12:17**. This is cut with two circular holes for the gauges, and of an overall size sufficient to overlap the extreme edges of the ashtray aperture. A convenient thickness of wood is $\frac{3}{16}$ in. The base and instruments are held in position by the clamps provided with the latter. The gauges are supplied complete with all fittings.

12:10 Fuel tank

The fuel tank is readily removed for cleaning or other attention. First detach the electrical leads from the fuel-gauge tank unit, noting the colour for reconnecting, as shown on **FIG 12:18**. On the 'Vitesse', the tank should be drained by means of the plug located behind the left side of the wheel arch. Disconnect the fuel pipe by withdrawing its rubber connection from the upper front corner of the tank. Remove the filler cap, take out the four screws which secure the tank to the support brackets, and lift the tank from the car.

To remove the 'Spitfire' tank, first take off the trim panel from inside the luggage locker; detach the filler pipe and hose, and the wiring from the tank gauge unit. Disconnect the fuel pipe and drain the fuel out. Remove the five screws holding the tank, and lift out the tank.

The procedure for tank replacement in all cases is a reversal of the foregoing.

12:11 Lamps and bulbs

The various driving lamps are of normal standard pattern, with easy access for exchange of faulty parts, bulbs, etc. While both styling and reflector techniques are subject to change fairly rapidly, in no case is there any added difficulty in regard to the essential requirements referred to, and as these are substantially the same for all modern cars, it is not considered necessary to reiterate familiar details. It should be made a practice to use only bulbs of established and reliable make, and of the power stipulated. Also, when there is any doubt about alignment of lamps, these should be tested by an agent equipped with the necessary precision apparatus; hit-and-miss methods must never be relied on.

APPENDIX

RANGE OF MODELS

Introduction and deletion dates

TECHNICAL DATA

Engine	Piston data	Ignition system
Cooling system	Fuel system	Clutch and transmission
Rear suspension spring	Front suspension springs	
Electrical system	Tightening torques	

WIRING DIAGRAMS

13:1	'Spitfire', 1147 cc
13:2	'Spitfire', 1296 cc
13:3	'Vitesse', 1596 cc
13:4	'Vitesse', 1998 cc
13:5	G.T.6, 1998 cc

GENERAL HINTS ON MAINTENANCE AND OVERHAUL

GLOSSARY OF TERMS

CAR PERFORMANCE

Explanatory definitions	Catalogue information
Engine output	Torque and brake rear pressure
Compression ratio	

RANGE OF MODELS AND DATES

	<i>Introduced</i>	<i>Discontinued</i>
VITESSE SIX SALOON, 1596 cc	May 1962	September 1966
VITESSE SIX CONVERTIBLE, 1596 cc	May 1962	September 1966
SPITFIRE Mk. I, 1147 cc	October 1962	December 1964
SPITFIRE Mk. II, 1147 cc... ..	March 1965	January 1967
VITESSE SIX 2-LITRE SALOON, 1998 cc...	October 1966	October 1968
G.T. SIX 2-LITRE, 1998 cc	October 1966	October 1968
SPITFIRE Mk. III, 1296 cc	March 1967	—

Notes: Improved versions of 'Vitesse' and 'G.T.6' were introduced in October 1968, having increased engine power, and rear suspension by leaf-spring with wishbones and trailing-arms.

TECHNICAL DATA

Dimensions are in inches unless stated otherwise. Engine performance figures are Nett

ENGINE

Piston stroke	...	...	...	...	...	...	76 mm
Cylinder bore:							
1147 cc	...	...	...	...	...	...	69.3 mm
1296 cc	...	...	...	...	...	...	73.7 mm
1596 cc	...	...	...	...	...	...	66.75 mm
1998 cc	...	...	...	...	...	...	75 mm
Compression ratio:							
1147 cc ('Spitfire' Mk I)	...	...	...	...	...	...	9.0:1
1147 cc ('Spitfire' Mk II)	...	...	...	...	...	...	9.0:1
1296 cc ('Spitfire' Mk III)	...	...	...	...	...	...	9.0:1
1596 cc ('Vitesse' Six)	...	...	...	...	...	...	8.75:1
1998 cc ('Vitesse' 2-litre)	...	...	...	...	...	...	9.5:1
1998 cc ('G.T.' Six)	...	...	...	...	...	...	9.5:1
Maximum bhp at rev/min:							
1147 cc ('Spitfire' Mk I)	...	...	...	...	...	...	63/5700
1147 cc ('Spitfire' Mk II)	...	...	...	...	...	...	67/6000
1296 cc ('Spitfire' Mk III)	...	...	...	...	...	...	75/6000
1596 cc ('Vitesse' Six)	...	...	...	...	...	...	70/5000
1998 cc ('Vitesse' 2-litre)	...	...	...	...	...	...	95/5000
1998 cc ('G.T.' Six)	...	...	...	...	...	...	95/5000
Maximum torque at rev/min (lb-ft)							
1147 cc ('Spitfire' Mk I)	...	...	...	...	...	...	67/3500
1147 cc ('Spitfire' Mk II)	...	...	...	...	...	...	67/3750
1296 cc ('Spitfire' Mk III)	...	...	...	...	...	...	75/4000
1596 cc ('Vitesse' Six)	...	...	...	...	...	...	92.5/2800
1998 cc ('Vitesse' 2-litre)	...	...	...	...	...	...	115/3000
1998 cc ('G.T.' Six)	...	...	...	...	...	...	115/3000
Main bearing journal diameter	...	...	...	...	...	...	2.0005–2.001
Main bearing internal diameter	...	...	...	...	...	...	2.0015–2.0025
Main bearing recommended running clearance	...	...	...	...	...	...	0.0005–0.0022
Main bearing housing internal diameter	...	...	...	...	...	...	2.146–2.1465
Thickness of thrust washers	...	...	...	...	...	...	0.091–0.093
End float of crankshaft (preferred)	...	...	...	...	...	...	0.004–0.008
Oversize thrust washers available	...	...	...	...	...	...	0.096–0.098
Crankpin diameter (4-cylinder)	...	...	...	...	...	...	1.6255–1.625
Crankpin diameter (6-cylinder)	...	...	...	...	...	...	1.875–1.8755
Big-end bearing internal diameter (4-cylinder)	...	...	...	...	...	...	1.627–1.626
Big-end bearing internal diameter (6-cylinder)	...	...	...	...	...	...	1.8777–1.8765
End-float of connecting-rod	...	...	...	...	...	...	0.008–0.012
Small-end bush bore	...	...	...	...	...	...	0.8126–0.8122
Gudgeon pin diameter	...	...	...	...	...	...	0.8125–0.8122
Gudgeon pin grading for fit (light push-in at 68°F):							
Size: high	...	...	...	...	...	...	Colour: white
Size: medium	...	...	...	...	...	...	Colour: green
Size: low	...	...	...	...	...	...	Colour: yellow
Note: Not applicable to interference—fit gudgeon pins							
Piston compression ring width	...	...	...	...	...	...	0.0787–0.0777
Piston oil control ring width	...	...	...	...	...	...	0.1563–0.1553
Piston ring gap in cylinder	...	...	...	...	...	...	0.013–0.008
Camshaft journal diameter	...	...	...	...	...	...	1.8402–1.8407

Camshaft bearing bore (in block) diameter	...	...	...	1.8433–1.8448
Camshaft end float	...	...	...	0.008–0.004
Camshaft sprocket wheel, number of teeth	...	...	...	42
Camshaft driving sprocket, number of teeth	...	...	...	21
Camshaft chain, number of pitches length	...	...	...	62
Oil pump, depth of rotor	...	...	...	0.9995–0.9985
Oil pump housing depth	...	...	...	1.002–1.001
Maximum clearance, outer rotor to body	...	...	...	0.008
Maximum clearance, outer to inner rotors	...	...	...	0.010
Distributor drive gear end-float	...	...	...	0.003–0.007
Distributor spindle diameter	...	...	...	0.499–0.498
Distributor spindle bush internal diameter	...	...	...	0.5005–0.501
Running clearance, spindle in bush	...	...	...	0.0005–0.003
Oil pressure relief valve spring:				
Free length	...	...	...	1.53
Fitted length	...	...	...	1.25
Load at fitted length (lb)	...	...	...	14.5
Valve guide length ('Spitfire' Mk. I and II)	...	...	...	2.25
Valve guide length ('Spitfire' Mk. III)	...	...	...	2.0625
Valve guide length ('Vitesse' and G.T.6)	...	...	...	2.72
Valve guide bore	...	...	...	0.313–0.312
Valve guide outside diameter	...	...	...	0.502–0.501
Valve spring ('Spitfire'):				
Number of coils	...	...	...	6
Fitted length	...	...	...	1.38
Fitted load	...	...	...	32 to 42 lb
Valve spring (outer, 1596 cc 'Vitesse'):				
Number of coils	...	...	...	7.25
Fitted length	...	...	...	1.36
Fitted load	...	...	...	27 to 30 lb
Valve spring (inner, 1596 cc 'Vitesse'):				
Number of coils	...	...	...	7.5
Fitted length	...	...	...	1.14
Fitted load	...	...	...	11 to 14 lb
Valve spring (outer, 1998 cc 'Vitesse' and G.T.6):				
Number of coils	...	...	...	7.25
Fitted length	...	...	...	1.386
Fitted load	...	...	...	27 to 30 lb
Valve spring (inner, 1998 cc 'Vitesse' and G.T.6):				
Number of coils	...	...	...	7.5
Fitted length	...	...	...	1.14
Fitted load	...	...	...	11 to 14 lb
Valve head diameter:				
Inlet ('Spitfire')	...	...	...	1.245–1.241
Inlet ('Vitesse' and G.T.6)	...	...	...	1.301–1.305
Exhaust ('Spitfire' Mk. I and II)	...	...	...	1.152–1.148
Exhaust ('Spitfire' Mk. III)	...	...	...	1.172–1.168
Exhaust (6-cylinder)	...	...	...	1.176–1.180
Valve stem diameter:				
Inlet	...	...	...	0.311–0.310
Exhaust	...	...	...	0.309–0.308
Valve timing (degrees crankshaft rotation):				
Inlet opens	...	...	...	25 18
Inlet closes	...	...	...	65 58
Exhaust opens	...	...	...	65 58
Exhaust closes	...	...	...	25 18

PISTON DATA

<i>Grading</i>	<i>F</i>	<i>G</i>	<i>H</i>
Bore diameter (1147 cc) ...	2.7283/2.7280	2.7287/2.7284	2.7291/2.7288
Piston top diameter (1147 cc) ...	2.7254/2.7250	2.7258/2.7254	2.7262/2.7258
Piston bottom diameter (1147 cc) ...	2.7272/2.7268	2.7276/2.7272	2.7280/2.7276
Bore diameter (1296 cc) ...	2.9000/2.8995	2.9005/2.9001	—
Piston top diameter (1296 cc) ...	2.8800/2.8752	2.8800/2.8752	—
Piston bottom diameter (1296 cc) ...	2.8981/2.8976	2.8987/2.8982	—
Bore diameter (1596 cc) ...	2.6279/2.6276	2.6283/2.6280	2.6287/2.6284
Piston top diameter (1596 cc) ...	2.6239/2.6236	2.6243/2.6240	2.6247/2.6344
Piston bottom diameter (1596 cc) ...	2.6267/2.6264	2.6271/2.6268	2.6275/2.6272
Bore diameter (1998 cc) ...	2.9408/2.9405	2.9412/2.9409	2.9416/2.9513
Piston top diameter (1998 cc) ...	2.9370/2.9366	2.9374/2.9370	2.9378/2.9374
Piston bottom diameter (1998 cc) ...	2.9388/2.9384	2.9392/2.9388	2.9396/2.9392

IGNITION SYSTEM

Initial advance (crankshaft degrees):

1147 cc ('Spitfire' Mk. I) ...	13 before tdc
1147 cc ('Spitfire' Mk. II) ...	17 before tdc
1296 cc ('Spitfire' Mk. III) ...	6 before tdc
1596 cc ...	10 before tdc
1998 cc ...	12 before tdc
Contact breaker gap ...	0.015
Spark plug gap ...	0.025
Spark plug, type ...	Champion N9Y

Note: Other makes of plug may be used if correctly selected from makers' charts. Always check with agent for latest recommendation when replacing plugs.

Cylinder firing order (4-cylinder) ...	1, 3, 4, 2
Cylinder firing order (6-cylinder) ...	1, 5, 3, 6, 2, 4
Contact breaker spring tension (oz) ...	18–24
Condenser capacity (mfd) ...	0.18–0.25

COOLING SYSTEM

Capacity (imperial pints), approximately:

'Spitfire' ...	8.5
'Vitesse' and G.T.6 ...	11.0
Filler cap blow-off pressure (lb/sq in) ...	7
Thermostat opening temperature ...	70°C
Thermostat fully open ...	85°C

Volume of anti-freeze required (percentage of coolant)

Min ambient temp	Percentage
–8°C	10
–13°C	15
–19°C	20
–29°C	25

FUEL SYSTEM

Fuel pump type ...	AC, mechanical
Fuel pump pressure (lb/sq in) ...	1.5–2.0
Twin carburetter, type:	
1147 cc ...	SU horizontal, H2
1296 cc ...	SU horizontal, H2
1596 cc, early ...	Solex downdraught, B32 P1H

1596 cc, later ...	...	...	...	...	...	...	Solex downdraught, B32 1H
1596 cc, final ...	...	...	...	...	...	...	Stromberg horizontal, CD150
1998 cc ...	...	...	...	...	...	...	Stromberg horizontal, CD150

CLUTCH AND TRANSMISSION

Type	...	...	...	...	...	Single dry plate			
Plate diameter ('Spitfire' Mk. I and II)	...	...	...	...	...	6.25			
Plate diameter ('Spitfire' Mk. III)	...	...	...	...	...	6.5			
Plate diameter (1596 cc)	...	...	...	...	...	8.0			
Plate diameter (1998 cc)	...	...	...	...	...	8.25			
Gearbox forward ratios with synchromesh:									
1998 cc	...	...	...	...	...	All			
Others	...	...	...	...	...	2nd, 3rd, 4th			
Transmission ratio:					1	2	3	4	Rev.
'Spitfire'	...	...	...	...	15.42	8.88	5.74	4.11	15.42
'Vitesse' 1596 cc	...	...	...	...	12.06	7.31	5.16	4.11	12.06
'Vitesse' 1998 cc	...	...	...	...	10.31	6.92	4.86	3.89	12.06
G.T.6 1998 cc	...	...	...	...	8.66	5.82	4.11	3.27	10.15

REAR SUSPENSION SPRING

Car type	No. of leaves	Test load (lb)	Laden negative camber
1147 cc 'Spitfire' ...	7	945	1.88
1296 cc 'Spitfire' ...	7	948	1.88
1596 cc Estate ...	7	1735	1.63
1596 cc Coupé ...	8	1010	0.93
1596 cc Convertible ...	11	1420	1.94
1596 cc Saloon ...	11	1420	1.54
1596 cc Heavy duty ...	12	1420	1.54
1998 cc Saloon ...	11	1420	1.54
1998 cc GT Six ...	8	1238	2.13

FRONT SUSPENSION SPRING

Car type	Free length	Fitted length	Fitted load (lb)
'Spitfire' ...	12.59	7.8	718
'Vitesse' ...	12.49	8.18	940
GT Six ...	12.46	8.06	880

ELECTRICAL SYSTEM

Battery capacity at 20-hr rate:							
1998 cc cars ...	...	...	...	...	...	...	56 amp/hr
Other cars ...	...	...	...	...	...	...	43 amp/hr
Generator type ...	...	...	...	...	...	...	Lucas C39PV2, C401 and C40L
Generator output at 13.5V:							
With load of 0.61 ohm—type C39PV2 ...	...	...	...	...	...	...	19 amp at 1900/2150 rev/min

With load of 0.61 ohm—type C401	...	...	...	...	22 amp at 2050/2250 rev/min
With load of 0.54 ohm—type C40L	...	...	...	...	25 amp at 2275 rev/min
Generator brush spring tension (oz)	...	...	...	...	22–25
Generator brush, minimum length	...	...	...	...	$\frac{11}{32}$ in
Control box:					
Cut-in volts	...	...	...	...	12.6–13.4
Drop-off volts	...	...	...	...	11.3–9.3
Open-circuit volts at ambient temperature	...	...	...	...	10°C 14.9–15.5 20°C 14.7–15.3 30°C 14.5–15.1 40°C 14.3–14.9
Starter motor:					
Type	...	...	...	...	Lucas, 4-brush, series wound
Brush spring tension (oz)	...	...	...	...	32–40
Brush minimum length	...	...	...	...	$\frac{5}{16}$ in

TIGHTENING TORQUES (lb ft)

Engine:

Camshaft chainwheel bolts	...	...	...	...	24–26
Camshaft thrust plate to block bolts	...	...	...	...	18–20
Clutch unit attachment bolts	...	...	...	...	18–20
Connecting rod cap bolts	...	...	...	...	38–42
Cylinder head nuts	...	...	...	...	42–46
Engine mounting to frame bracket bolts	...	...	...	...	18–20
Fan to pulley bolts ('Spitfire')	...	...	...	...	6–8
Fan to pulley bolts ('Vitesse'/ G.T.6)	...	...	...	...	12–14
Flywheel attachment bolts	...	...	...	...	42–46
Front engine bracket and plate bolts	...	...	...	...	18–20
Fuel pump flange nuts	...	...	...	...	12–14
Generator bracket to block bolts	...	...	...	...	16–18
Generator bracket to block bolts ('Spitfire' Mk. III only)	...	...	...	...	18–20
Generator pulley attachment	...	...	...	...	10–12
Generator to engine plate	...	...	...	...	16–18
Generator to mounting bracket	...	...	...	...	18–20
Gearbox bellhousing to engine plate	...	...	...	...	14–16
Main bearing cap bolts	...	...	...	...	50–55
Manifold outlet (exhaust) nuts	...	...	...	...	12–14
Manifold outlet nuts ('Vitesse'/G.T.6 only)	...	...	...	...	14–16
Manifold to head nuts	...	...	...	...	24–26
Manifold to head nuts ('Vitesse'/G.T.6 only)	...	...	...	...	20–22
Oil filter to crankcase	...	...	...	...	15–18
Oil pump to block bolts	...	...	...	...	6–8
Oil pump to block bolts ('Spitfire' Mk. III only)	...	...	...	...	8–10
Rear oil seal housing bolts	...	...	...	...	18–20
Rocker box nuts	...	...	...	...	1.5
Rocker pedestal nuts	...	...	...	...	24–26
Starter motor flange bolts	...	...	...	...	26–28
Sump attachment bolts	...	...	...	...	16–18
Sump to seal bolts	...	...	...	...	10–12
Timing cover bolts	...	...	...	...	14–16
Timing cover slotted setscrews	...	...	...	...	8–10
Water elbow to housing bolts	...	...	...	...	16–18
Water pump to head bolts	...	...	...	...	18–20
Water pump to pulley attachment	...	...	...	...	14–16

Gearbox:	
Clutch housing to gearbox bolts ...	24-26
Rear extension to gearbox bolts ...	14-16
Rear extension to top cover bolts ...	12-14
Slave cylinder to bracket bolts ...	10-12
Rear axle and suspension:	
Backplate bolts ...	16-18
Bearing cap to housing bolts ...	32-34
Hypoid housing bolts ...	16-18
Mounting plate to hypoid housing bolts ...	26-28
Radius arm brackets to frame bolts ...	24-26
Radius arms to bracket bolts ...	24-26
Rear axle to frame bolts ...	38-40
Rear damper lower attachment bolts ...	30-32
Rear damper upper attachment pin ...	42-46
Road spring to axle unit nuts ...	28-30
Shaft joint to inner axle shaft bolts ...	24-28
Shaft joint to inner axle shaft bolts ('Vitesse'/G.T.6 only) ...	32-36
Spring ends to vertical link plate bolts ...	42-46
Vertical link plates to hub inner bolts ...	42-46
Front suspension:	
Anti-roll bar link assembly ...	38-42
Anti-roll bar nuts ...	12-14
Anti-roll bar to chassis 'U' bolt nuts ...	3-4
Backplate and tie rod levers to vertical link bolts ...	26-28
Ball assembly to upper wishbone bolts ...	16-18
Ball assembly to vertical link bolts ...	38-42
Brake disc to hub bolts ...	32-35
Caliper plate to link and lever bolts ...	18-20
Caliper to plate bolts ...	50-55
Damper unit bottom bolts ...	42-46
Front suspension and engine bracket to frame bolts ...	26-28
Fulcrum brackets to lower wishbone bolts ...	26-28
Stub axle to vertical link ...	55-60
Tie rod end ball joint assembly pins ...	26-28
Top wishbone attachment bolts ...	26-28
Trunnion to wishbone bolts ...	35-38
Wishbone assembly to frame attachments ...	22-24
Vertical link to tie rod lever bolts ...	32-35
Steering gear:	
Coupling pinch bolts ...	18-20
Lower to upper clamp bolts ...	6-8
Safety clamp socket screw ...	18-20
Steering column safety clamp ...	6-8
Steering gearbox 'U' bolt nuts ...	14-16

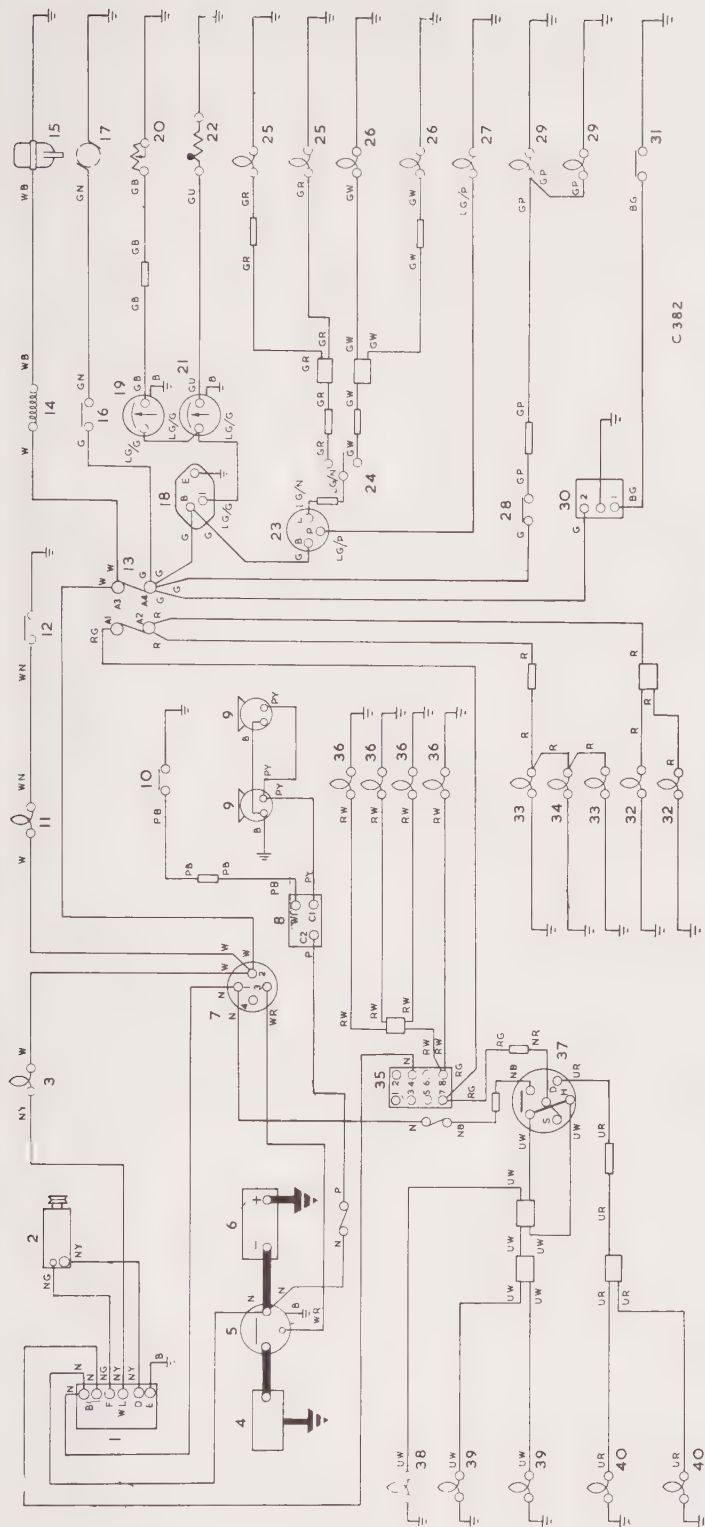


Fig 13:1 Wiring diagram, 'Spitfire', 1147 cc.

Key to Fig 13:1 1 Control box. 2 Generator. 3 Ignition warning lamp. 4 Starter motor. 5 Starter solenoid. 6 Battery. 7 Ignition/starter switch. 8 Horn fuse. 9 Horns. 10 Horn push. 11 Oil warning lamp. 12 Oil pressure switch. 13 Fuse unit. 14 Ignition coil. 15 Heater blower motor. 16 Voltage stabilizer. 17 Fuel tank unit. 18 Fuel indicator. 19 Turn signal lamps, right-hand side. 20 Turn signal lamps, left-hand side. 21 Temperature indicator. 22 Heater blower switch. 23 Flasher unit. 24 Turn signal switch. 25 Turn signal lamps, right-hand side. 26 Turn signal lamps, left-hand side. 27 Turn signal monitor. 28 Brake/stop lamp switch. 29 Brake/stop lamps. 30 Wipers wiper motor. 31 Wiper motor switch. 32 Front parking lamps. 33 Tail lamps. 34 Plate illumination lamps. 35 Master lighting switch. 36 Instrument illumination. 37 Steering column light switch. 38 Main beam warning lamp. 39 Headlamp main beams. 40 Headlamp dipped beams.

CABLE COLOUR CODE B Black D Dark G Green K Pink L Light M Medium N Brown P Purple R Red S Slate U Blue W White Y Yellow

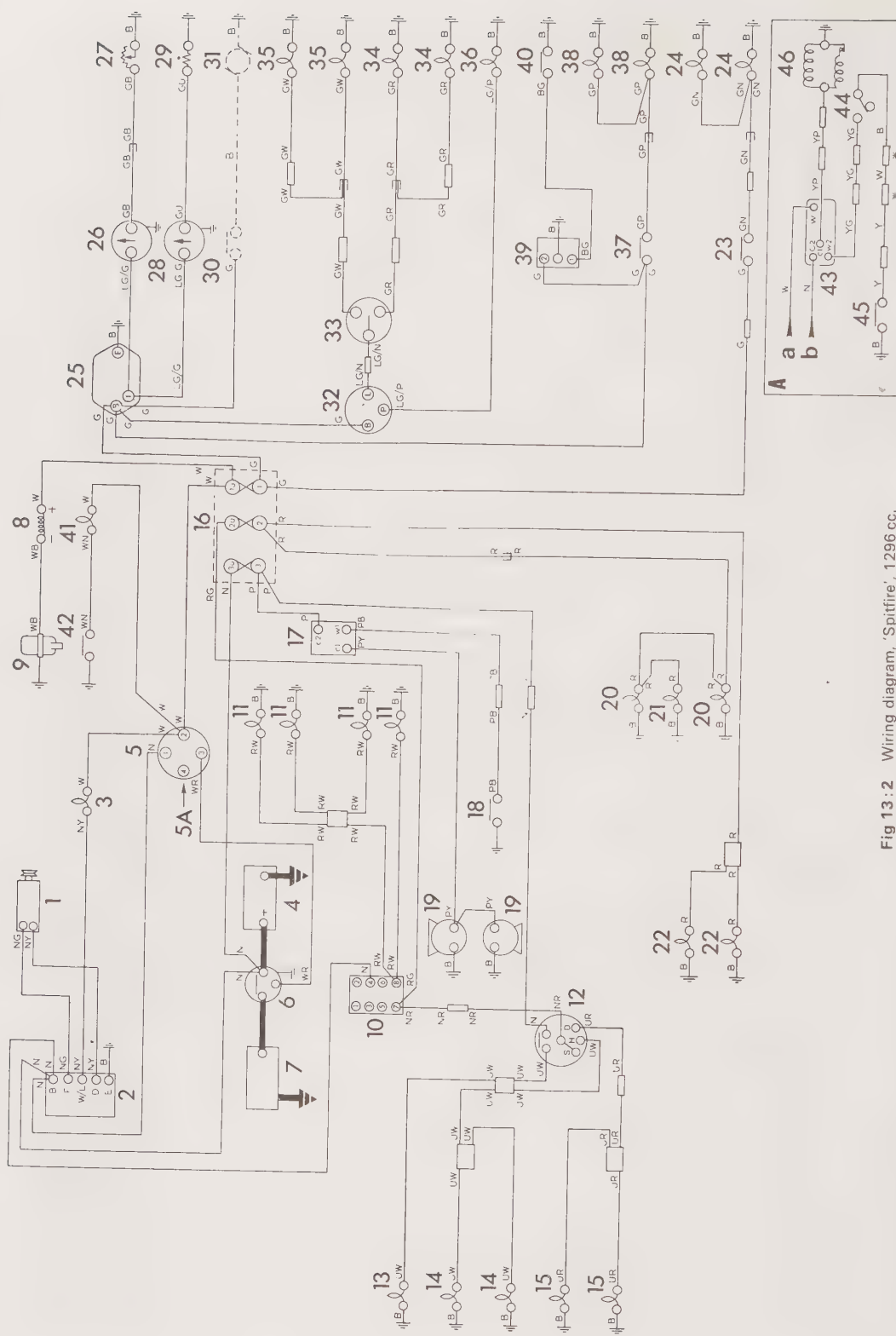


Fig 13:2 Wiring diagram, 'Spitfire', 1296 cc.

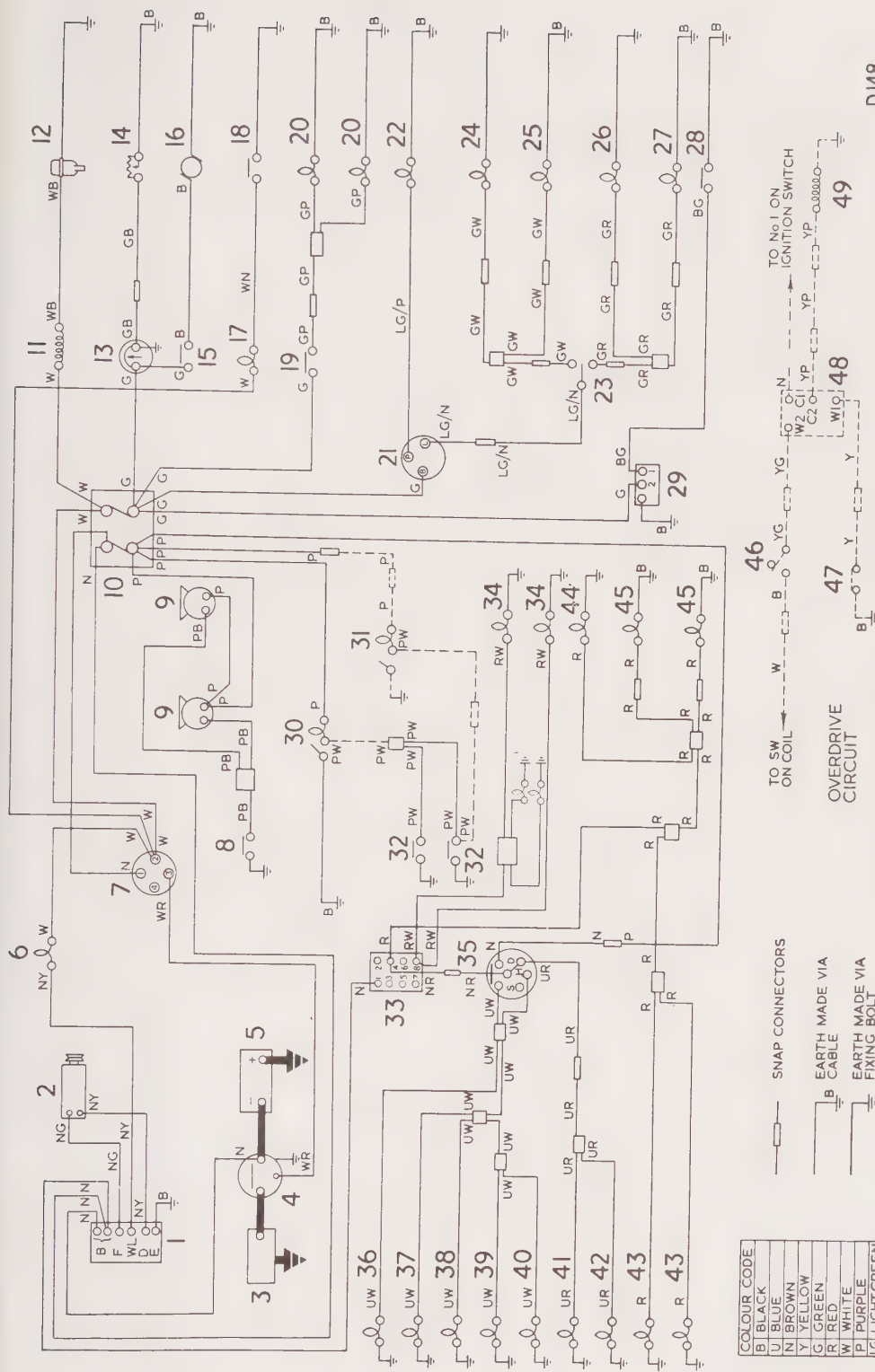


Fig 13:3 Wiring diagram, 'Vitesse', 1596 cc.

The facia lamp (30) is operated from the courtesy switches (32), on Convertible models. On Saloon models, these switches operate the roof lamp (31) (which is not fitted to Convertible models) and the facia lamp is independently controlled.

Key to Fig 13:3

- 1 Regulator.
- 2 Generator.
- 3 Starter motor.
- 4 Starter solenoid.
- 5 Battery.
- 6 Ignition warning light.
- 7 Ignition/start/accessory switch
- 8 Horn push.
- 9 Twin horns.
- 10 Fuse box.
- 11 Coil.
- 12 Distributor.
- 13 Fuel gauge.
- 14 Tank unit.
- 15 Heater switch.
- 16 Heater motor.
- 17 Oil pressure warning light
- 18 Oil pressure switch.
- 19 Stop lamp switch.
- 20 Stop lamps.
- 21 Flasher unit.
- 22 Flasher warning lights.
- 23 Flasher switch.
- 24 R.H. front flasher.
- 25 R.H. rear flasher.
- 26 L.H. front flasher.
- 27 L.H. rear flasher.
- 28 Wiper switch.
- 29 Wiper motor.
- 30 Facia lamp.
- 31 Roof lamp.
- 32 Courtesy switch.
- 33 Master lighting switch.
- 34 Panel light
- 35 Column lighting and headlamp flasher switch.
- 36 Main beam warning light.
- 37 L.H. outer main beam.
- 38 L.H. inner main beam.
- 39 R.H. outer main beam.
- 40 R.H. inner main beam.
- 41 L.H. dip beam.
- 42 R.H. dip beam.
- 43 L.H. side lamp.
- 44 Number plate illumination lamp.
- 45 R.H. tail lamp.
- 46 Overdrive switch.
- 47 Gearbox switch.
- 48 Relay.
- 49 Solenoid.

*Special order.

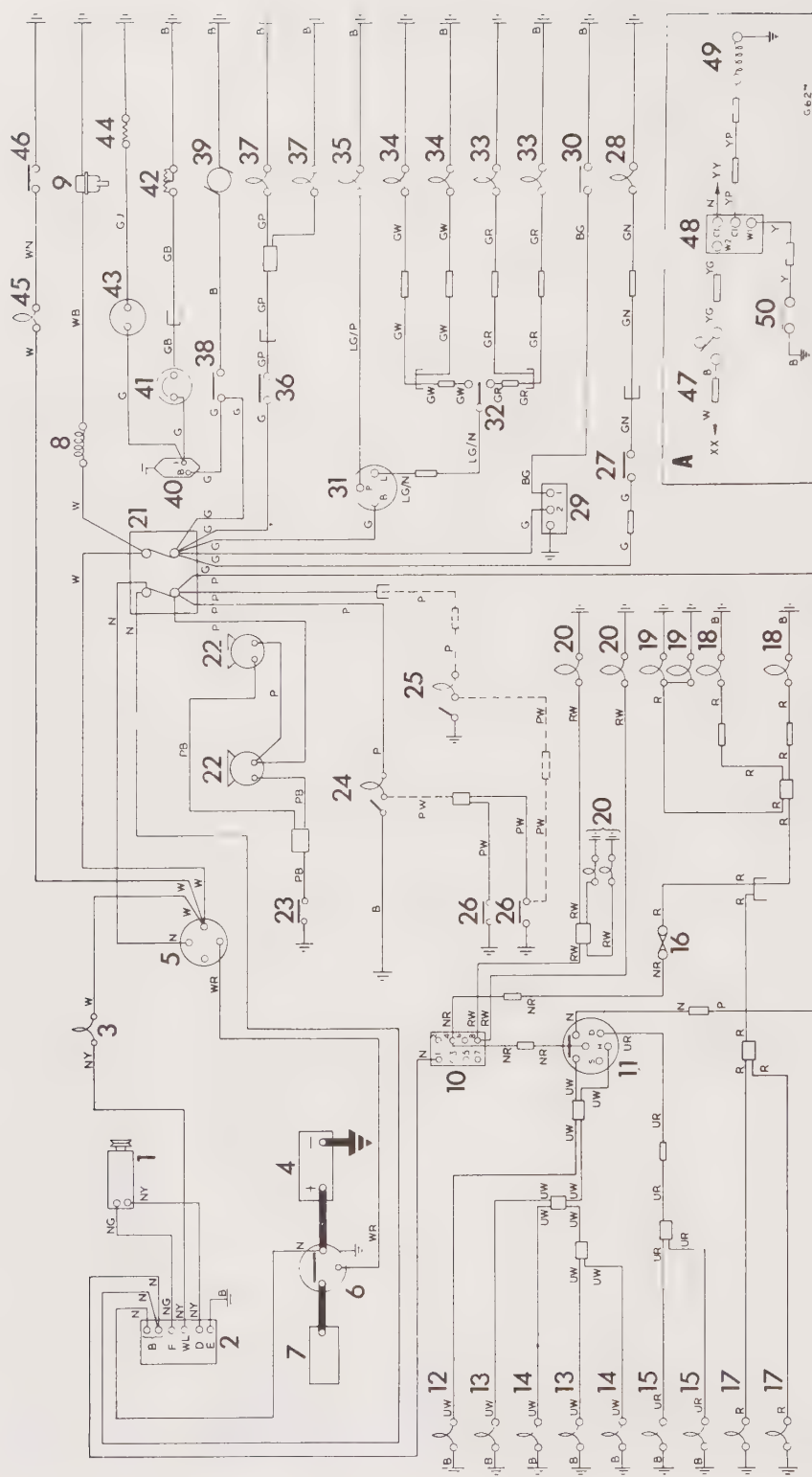


Fig 13.4 Wiring diagram, 'Vitesse', 1998 cc.

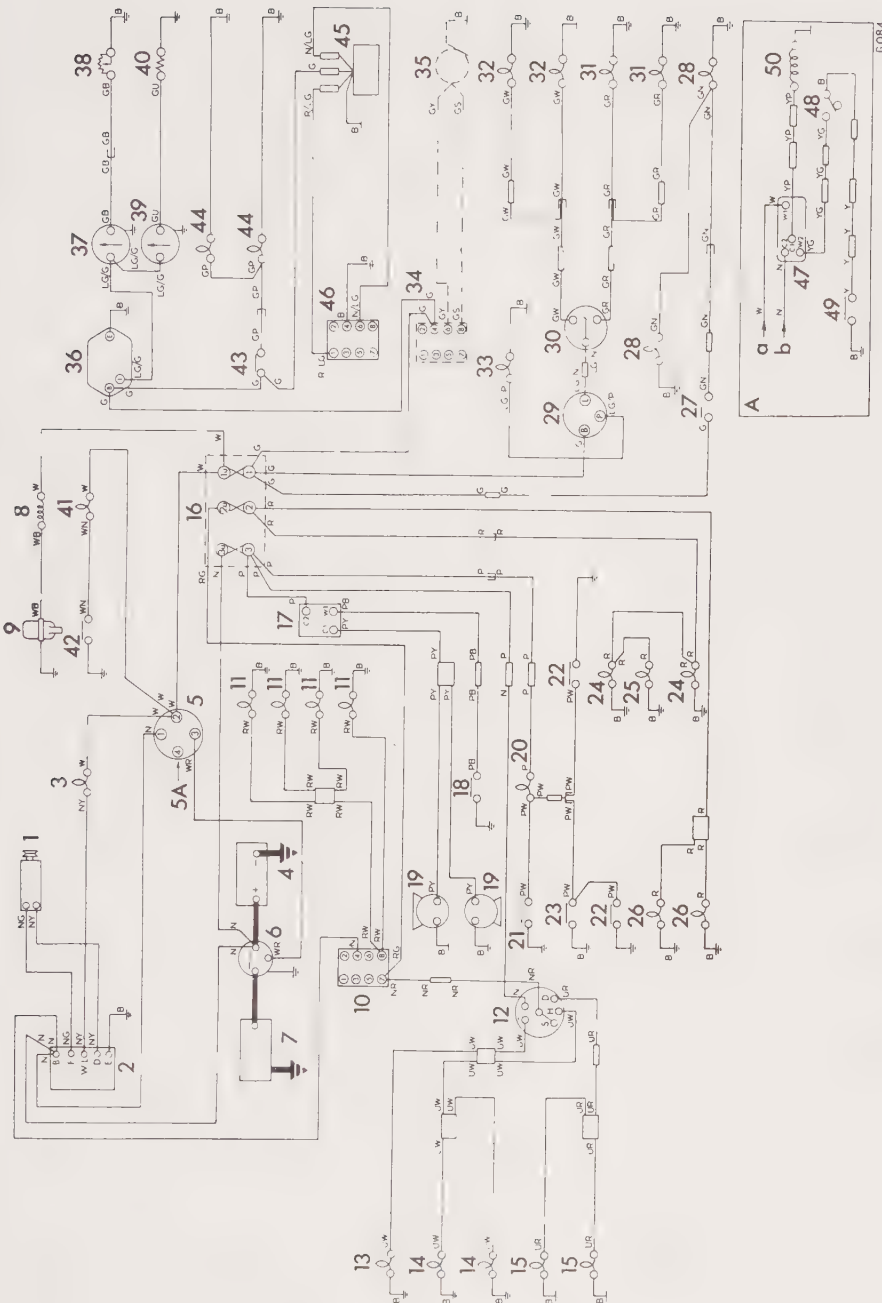


Fig 13:5 Wiring diagram, G.T.6, 1998 cc.

Key to Fig 13:9

1 Generator. 2 Control box. 3 Ignition warning light. 4 Battery. 5 Ignition/starter switch. 5A Ignition/starter switch—Radio supply connector. 6 Starter solenoid. 7 Starter motor. 8 Ignition coil. 9 Ignition Distributor. 10 Master light switch. 11 Instrument illumination. 12 Column light switch. 13 Main beam warning light. 14 Main beam. 15 Dip beam. 16 Fuse assembly. 17 Horn relay. 18 Horn push. 19 Horn. 20 Roof lamp. 21 Roof lamp rear door switch. 22 Roof lamp door switch. 23 Roof lamp fascia switch. 24 Tail lamp. 25 Plate illumination lamp. 26 Front parking lamp. 27 Reverse lamp switch. 28 Reverse lamp. 29 Flasher unit. 30 Flasher switch. 31 L.H. flasher lamp. 32 R.H. flasher lamp. 33 Flasher warning light. 34 Heater switch (optional extra). 35 Heater motor (optional extra). 36 Voltage stabilizer. 37 Fuel indicator. 38 Fuel tank unit. 39 Temperature indicator. 40 Temperature transmitter. 41 Oil pressure warning light. 42 Oil pressure switch. 43 Stop lamp switch. 44 Stop lamp. 45 Windscreen wiper motor. 46 Windscreen wiper switch. 47 Overdrive relay. 48 Overdrive column switch. 49 Overdrive gearbox switch. 50 Overdrive solenoid. a From ignition/starter switch—connector 2. b From ignition/starter switch—connector 1.

CABLE COLOUR CODE B Black D Dark G Green K Pink L Light M Medium N Brown P Purple R Red S Slate U Blue W White Y Yellow

GENERAL HINTS ON MAINTENANCE AND OVERHAUL

There are few enterprises more rewarding than the restoration of a car to its original peak of efficiency and smooth performance. The following notes are intended to help the owner to reach that state of perfection. Providing that he possesses the basic manual skills he should have no difficulty in performing most of the operations detailed in this manual. It must be stressed, however, that highly-skilled work which entails the use of expensive special tools and gauging equipment should be entrusted to the experts who have such equipment. Also, these notes must not be regarded as in any way superseding or modifying the specific information contained in this book.

Problems

The chief problems which may face an operator are:

- 1 External dirt
- 2 Difficulty in undoing tight fixings
- 3 Dismantling unfamiliar mechanisms
- 4 Deciding in what respect parts are defective
- 5 Confusion about the correct order for reassembly
- 6 Adjusting running clearances
- 7 Final tuning

Practical suggestions to solve the problems

- 1 Use newspaper instead of rag for preliminary cleaning. Having removed most of the dirt, continue with a brush and paraffin. Progressive cleaning is best done with two containers of paraffin, using the second one for those parts which are almost clean.

Finish off with clean petrol. This will dry, eliminating the use of rag which may leave clogging fibres behind. Do not dismantle anything until the outside has been cleaned, particularly round joints which will be separated. This ensures that gritty dirt cannot fall inside. Be careful not to wash dirt into holes. Plug them first, but do not use matchsticks, as these may break off short. If dirt can enter, blank off all orifices in parts which will be dismantled for some time, but be sure that the material used cannot be pushed into a place where it would be difficult to remove. This applies, for example, to the plugging of water passages in the top face of a cylinder block.

- 2 It is not advisable to hammer on the end of a screw thread, but if it must be done, first screw on a nut so that it is flush with the end. This applies particularly to the removal of cotters. Nuts and bolts seem to 'grow' together, especially in exhaust systems. If penetrating oil does not work, try plenty of heat, but be careful of starting a fire. Asbestos sheet or cloth is useful to isolate heat.

Tight bushes or pieces of tail pipe rusted into a silencer can be removed by splitting them with an open-ended hacksaw. Tight screws can be started by hammering on the end of an all-metal screwdriver. Many tight fixings will yield to the judicious use of a hammer, but it must be a soft-faced hammer if damage to surfaces is to be avoided. This treatment is very useful when trying to part tapered fixings such as those of a steering ball joint pin in a steering arm. Distortion of the arm is prevented by holding a heavy metal block or 'dolly' on the opposite side of the boss.

- 3 It often happens that an owner is baffled when trying to dismantle an unfamiliar piece of equipment. So many modern devices are pressed together or assembled by spinning-over flanges, that they must be sawn apart. The intention is that the whole assembly must be renewed. However, parts which appear to be in one piece to the naked eye, may reveal close-fitting joint lines when inspected with a magnifying glass, and this may provide the necessary clue to dismantling.

Be very careful when dismantling mechanisms which may come apart suddenly. Work on a sheet of paper which will catch everything as it falls, and drape a piece of cloth over the device if springs are likely to fly in all directions. Mark everything which might be reassembled in the wrong position, scratching a line across joint faces before parting them, and using scratch symbols where necessary. A sequence of tiny dots from a centre punch are also useful to identify the position of apparently identical parts, but be quite sure that any marks will not weaken the part or damage working surfaces. **Springs and torsion bars, for instance, must never be scratched or marked.** Store parts which look alike in the correct order for reassembly. Never rely upon memory to assist in the assembly of complicated mechanisms, especially when they will be dismantled for a long time. Make notes, draw diagrams, and put labels on detached wires.

- 4 Rust stains may indicate unlubricated wear. This can sometimes be seen around the outside edge of a bearing cup in a universal joint.

Look for bright rubbing marks on parts which normally should not make heavy contact. These might prove that something is bent or running out of truth. For example, there might be bright marks on one side of a piston, at the top near the ring grooves, and others at the bottom of the skirt on the other side. This could well be the clue to a bent connecting rod.

Test parts for wear, especially ball- and roller-bearings, by first washing them free from lubricants. Accurate checks are best made with expensive tools like micrometers, but much can be done by getting the right 'feel' with a pair of calipers or a vernier gauge, especially if the latter has jaws for both inside and outside measurements. Sometimes it is possible to make quite accurate dimensional checks by using something of known diameter, like a twist drill shank, to set the calipers or vernier gauge.

The clearance between parts can often be measured by bolting them together with a tiny piece of lead wire or cored solder in between. This will be flattened to the dimension of the clearance. Such a method is very handy when trying to shim a housing which locates a bearing endwise, as it does in some hubs and gearboxes. Alternatively, use a proprietary material like 'Plastigage'.

Sometimes joint faces leak persistently, even after gasket renewal. The fault will then be traceable to distortion, to dirt or to burrs. The last-named can be found by rubbing a smooth flat file over the faces, spanning opposite surfaces if possible, so that the file is kept flat. This will remove burrs without damaging the joint faces. Studs which are screwed into soft metal

frequently raise burrs at the point of entry. A quick cure for this is to chamfer the edge of the hole in the part which fits over the stud.

Always check a replacement part with the original one before it is fitted.

- 5 If parts are not marked, and the order for reassembly is not known, a little detective work will help. Look for marks which are due to wear to see if they can be mated. Joint faces may not be identical due to manufacturing errors, and parts which overlap may be stained, giving a clue to the correct position. Most fixings leave identifying marks especially if they were painted over on assembly. It is then easier to decide whether a nut for instance, has a plain, a spring, or a shakeproof washer under it. All running surfaces become 'bedded' together after long spells of work and tiny imperfections on one part will be found to have left corresponding marks on the other. This is particularly true of shafts and bearings and even a score on a cylinder wall will show on the piston.
- 6 Checking end float or rocker clearances by feeler gauge may not always give accurate results because of wear. For instance, the rocker tip which bears on a valve stem may be deeply pitted, in which case the feeler will simply be bridging a depression. Thrust washers may also wear depressions in opposing faces to make accurate measurement difficult. End float is then easier to check by using a dial gauge.

It is common practice to adjust end play in bearing assemblies, like front hubs with taper rollers, by doing up the axle nut until the hub becomes stiff to turn and then backing it off a little. **Do not use this method with ball bearing hubs as the assembly is often preloaded by tightening the axle nut to its fullest extent.** If the splitpin hole will not line up, file the base of the nut a little.

Steering assemblies often wear in the straight-ahead position. If any part is adjusted, make sure that it remains free when moved from lock to lock. Do not be

surprised if an assembly which is known to be carefully adjusted outside the car, becomes stiff when it is bolted in place. This will be due to distortion of the case by the pull of the mounting bolts, particularly if the mounting points are misaligned or the bolts unevenly tightened. This problem may be remedied by careful attention to the alignment of mounting points, and correct fitting.

- 7 When a spanner is stamped with a size and A/F it means that the dimension is the width between the jaws and has no connection with ANF, which is the designation for the American National Fine thread. Coarse threads like Whitworth are rarely used on cars today except for studs which screw into soft aluminium or cast iron. For this reason it might be found that the top end of a cylinder head stud has a fine thread and the lower end a coarse thread to screw into the cylinder block. If the car has mainly UNF threads, it is likely that any coarse threads will be UNC, which are not the same as Whitworth. Small sizes have the same number of threads in Whitworth and UNC, but in the $\frac{1}{2}$ inch size for example, there are twelve threads to the inch in the former and thirteen in the latter.
- 8 **It is useless to tune an engine which has not reached its normal running temperature.** In the same way, the tune of an engine which is stiff after a rebore will be different when the engine is again running free. Remember too, that rocker clearances on pushrod operated valve gear will change when the cylinder head nuts are tightened after an initial period of running with a new head gasket.

Trouble may not always be due to what seems the obvious cause. Ignition, carburation and mechanical condition are interdependent and spitting back through the carburettor, which might be attributed to a weak mixture, can be caused by a sticking inlet valve.

For one final hint on tuning, never adjust more than one thing at a time or it will be impossible to tell which adjustment produced the desired result.

GLOSSARY OF TERMS

A		Collet	
AF	Across flats of nut or bolt head. Width between spanner jaws.	Commutator	Collar, often split and located in a groove in a shaft, e.g. on a valve stem. Rotating segmented current distributor between armature windings and brushes in a generator or motor. See 'Capacitor'.
Allen key	Wrench of hexagonal bar used to turn socket-head screws.	Condenser	See 'Capacitor'.
ANF	American National Fine screw thread	Core plug	Thin metal discs blanking off manufacturing holes in castings. See 'Welch plug'.
Annulus	Ring-like space.	Crown wheel	Large gear with ring of teeth at shallow angle on one face. Typically meshes with bevel pinion in rear axle.
Armature	Of generator or starter motor—part which revolves in a magnetic field. Of a solenoid—plunger which is pulled into a hollow magnet.	'C' spanner	Shaped like a 'C' with an extended handle. The top hook engages in slots round the periphery of e.g. a screwed collar.
Assymmetrical	Not quite symmetrical.	CVC	Constant voltage control.
AVC	Automatic voltage control.	D	
Axial	A part belonging to, or revolving round, an axis. Linear movement of a shaft.	Damper	Alternative term for shock absorber. Used in suspension systems to damp out spring oscillations.
B		Depression	The lowering of atmospheric pressure e.g. in the inlet manifold and carburetter.
BA	British Association screw thread. Frequently used for small screws associated with electrical equipment.	Dowel	Close-fitting peg, tube or bolt which accurately locates holes in mating parts.
Backlash	Play between parts, e.g. between teeth of meshing gears.	Drag link	Rod connecting steering gearbox arm to nearest road wheel.
Balance lever	A cross-lever which divides a central push or pull equally between two rods or cables attached to the outer ends.	Dry liner	Thinwalled tube pressed into bored-out engine cylinder to form bore.
Banjo axle	Hollow rear axle casing with large diameter housing to accommodate the drive gears.	Dry sump	Does not store main oil supply, which is scavenge-pumped into a separate tank.
Bendix pinion	Self-engaging drive on starter motor shaft.	Dynamo	Academic term for DC Generator (strictly applicable to both DC generators and motors).
Bevel pinion	Small gear with sloping teeth on side face. Meshes with another gear at an angle to it (usually a right angle).	E	
BSF	British Standard Fine screw thread. Now almost superseded by UNF on cars.	Electrode	Terminal point in electrical circuit, e.g. sparking plug points.
BSP	British Standard Pipe screw thread. A fine thread for pipe work. Can be parallel or tapered. Size indicates bore of thickwalled pipe, not top of thread diameter.	Electrolyte	In car batteries, a solution of sulphuric acid and distilled water.
BSW	British Standard Whitworth screw thread. A coarse thread rarely used on cars except for permanent stud fixings.	End float	Or end thrust. Free endwise movement of a part, e.g. shafts and parts mounted on shafts.
Bypass	(Oil filter)—one which cleans a small volume of oil from the pump and returns it to the sump. (General) Alternative flow path, usually valve controlled.	EP	Extreme pressure lubricants for arduous duties, e.g. between the teeth of rear axle gears.
C		F	
Camber	Angle at which a wheel is tilted from the vertical.	Fade	Of brakes. Reduced efficiency due to heat.
Capacitor	Modern term for electrical condenser. Used in ignition distributor.	Field coils	Stationary windings to produce magnetism in generators or motors.
Castellated nut	Top face slotted across to take a locking splitpin.	Fillets	Narrow finishing strips usually applied to interior bodywork.
Castor	Angle at which the kingpin or swivel pin is tilted when viewed from the side.	First motion shaft	Input shaft from clutch into gearbox.
Clevis	A U-shaped fork much used in brake cable connections.	Fullflow	An oil filter which cleans all the oil all the time unless the element is clogged, when a relief valve opens.
Clockwise	As normal rotation of clock hands when viewing face of object.		

G		M	
Gear pump	For oil. Pumps it round between the outer teeth of two meshing gears and a close fitting casing.	Mandrel	Axle or cylindrical rod used for centring purposes.
Generator	Correct term for Dynamo, when producing electricity from rotating energy.	Manifold	A pipe or duct with several branches.
Grommet	A ring of protective or sealing material.	N	
H		Needle rollers	Bearing rollers of small diameter and relatively long in proportion.
Halfshaft	One of a pair transmitting power from the differential gearing to the rear wheel hubs.	O	
h.c.	High compression ratio in an engine cylinder and combustion chamber.	Oil bath	A reservoir which lubricates working parts by immersion. In air filters, a separate oil supply for wetting a wire-mesh element and collecting impurities.
Helical	Spiral, as in a valve spring. Helical gear—one having curved or spiral-form teeth.	Oil wetted	In air filters, the wetting of a wiremesh element by dipping in oil and allowing to drain.
Hot spot	Warms mixture from carburettor on its way to engine. Often provided by clamping inlet and exhaust manifolds together.	Overlap	Period during which the inlet and exhaust valves are open simultaneously.
HT	High tension (voltage) electricity. Produced by coil for spark plugs.	P	
Hydrometer	Used to test Specific Gravity of battery electrolyte. Withdraws sample to lift graduated float.	Panhard rod	Transverse link connected between the car frame and axle casing to restrict sideways movement.
Hypoid bevel gears	Small bevel pinion meshing below centre line of crown wheel in rear axle. Gives lower propeller shaft line.	Pawl	Pivoted lever engaging in teeth of a ratchet wheel to prevent reverse rotation.
I		Peg spanner	One with two spaced pegs which engage in holes in a part required to be rotated.
Idler	Passes on movement, e.g. a gear between input and output gears. Transmits track rod movement to side rods in steering gear.	Pendant pedals	Pedal levers which are pivoted at the top.
i.f.s.	Independent front suspension.	Phillips screwdriver	Fluted blade with a cross point to engage the crossed slots in a special screw head.
Impeller	Of a water pump. Vaned disc rotating to stimulate flow.	Pinion	The smaller of two gears or chain sprockets. Also applied to any small gear.
J		Piston-type damper	Damping pistons work in cylinders in a housing. Pistons reciprocated by attachment to suspension system.
Journals	Those parts of a shaft which are in contact with the bearings.		ciprocated by linkage to suspension system.
K		Preloading	End pressure on ball or roller bearings, deliberately induced on assembly and not due to working loads.
Kerosene Kingpin	Paraffin. Main vertical pin. Typically carries front stub axle and road wheel.	R	
L		Radial Radius rod	Like rays or spokes in a wheel. Pivoted arm restraining a moving part to make it travel in an arc.
Laminations Layshaft	Leaves, as in a suspension spring. Often called the second motion shaft. A cluster of gears driven by the input or first motion shaft in a gearbox.	Ratchet	Toothed wheel or rack which can move in one direction only, return being prevented by pawl.
l.c.	Low compression ratio in engine cylinder and combustion chamber.	Recessed-head screw	Crossed slots in head need special (Phillips) screwdriver.
Little-end	The small end of a connecting rod. Eye receives the gudgeon pin.	Ring gear	Ring of gear teeth attached to flywheel. Starter pinion engages with it.
l.s.	The leading shoe in a drum brake. Tends to wedge into drum, so increasing the braking effect.	Run-out	Amount by which a rotating part is out of truth.
LT	Low tension (voltage) electricity, usually battery rating in cars.	S	
		SAE	Society of Automotive Engineers (USA).

Semi-floating axle	Outer end of rear axle halfshaft is carried on bearing inside axle casing. Wheel hub secured to end of shaft.	Third motion shaft	Output shaft of gearbox carrying gears which mesh with those on the layshaft.
Servo	Additional power applied to a control, often by vacuum, e.g. vacuum-servo for powerful brake operation.	Three-quarter floating axle	Inner end of axle shaft splined to differential side gear, outer end flanged and bolted to hub. Hub runs on bearing mounted on outside of axle casing.
Setscrew	Hexagon-headed screw with shank threaded for entire length.	Thrust bearing or washer	Reduces friction caused by end thrust of shafts or rotating parts.
Shackle	Coupling link. Two parallel pins connected by side plates to control the moving end of a leaf spring.	Track rod	Bar across vehicle which connects both steering arms together.
Shell bearing	Thin steel tube lined with anti-friction metal. Used in halves for main bearings and big-end bearings.	t.s.	The trailing shoe in a drum brake. Has tendency to be pushed away from rotating drum.
Silentbloc bearing	Rubber bush bonded to inner and outer metal sleeves. Permits small rotational movements.	U	
Socket-head screw	Deep screw head with central hexagonal socket. Turned by hexagonal Allen key.	U.J.	Universal joint in propeller shaft or drive shaft.
Solenoid	Coil of wire which becomes a magnet when electric current passes. Will draw in a soft iron plunger.	UNF	Unified National Fine screw thread.
Spur gear	One with straight teeth.	V	
Stator tube	Stationary tube inside moving steering column to carry horn and indicator wiring.	Vacuum-servo	Gives extra power, particularly for brake operation by using the partial vacuum in the inlet manifold.
Stub axle	Short projecting axle fixed at one end only.	Venturi	A smooth specially shaped throat in a tube which increases the speed of air or fluid passing through it.
T		Vernier	A small graduated scale used to obtain fraction readings of a coarser scale.
Tachometer	Instrument which measures velocity. Term now popularized for engine rev/min indicator.	W	
TDC	Top dead centre when piston is at top of its travel. BTDC and ATDC indicate before and after top dead centre.	Welch plug	A domed thin metal disc which is partially flattened to make it lock in a machined recess. Much used as a core plug in castings like cylinder blocks.
Thermostat	Automatic device for regulating temperature.	Wet linear	Renewable cylinder barrel with sealing rings at each end. Is surrounded by engine coolant.
		Wet sump	The usual form, consisting of a pan beneath the crankcase which holds all the lubricating oil.

CAR PERFORMANCE

EXPLANATORY DEFINITIONS

On occasion, even the well-informed find it difficult to convey in simple language the meaning of commonplace technical terms. The following definitions may prove useful in such situations.

Horse-power (hp):

The unit of work; 1 hp is equal to 33,000 ft lb per min. This is the work done in lifting a weight of 33,000 lb through a distance of one foot in one minute, or any other quantities of pounds and feet which when multiplied give 33,000.

Brake horse-power (bhp):

The actual power developed at the engine-shaft, as measured on test by coupling the engine to a dynamometer or 'brake' for absorbing the power.

Torque:

The effort applied to a shaft or wheel which tends to turn it. When the torque is of sufficient value to rotate the shaft through a definite distance in a given time, work is done, which is then stated in hp.

Mean effective pressure (mep), or mean indicated pressure (mip):

The average pressure produced in the cylinders on the explosion stroke, and which results in the shaft-power. It is measured at the cylinder itself, by a scientific apparatus, or indicator.

Brake mean effective pressure (bmep) or brake mean pressure (bmp):

A figure analogous to the above, but obtained by calculation from the actual bhp. The figure is imaginary, as it allows for the mechanical losses in the engine. It does however enable useful comparisons to be made between designs, in almost all relevant aspects.

Mechanical efficiency:

A factor expressed as a percentage, which shows how much of the explosion pressure is obtained as power at the engine-shaft; it is the percentage difference between the mep and the bmep. The loss is due to friction, inertia, etc., in the engine moving parts, plus the pumping work in charging and exhausting.

Thermal efficiency:

A factor expressed as a percentage which shows how much power is obtained from the heat energy in the fuel used; it is thus an indication of the effectiveness of the engine as an apparatus for converting heat into work.

Volumetric efficiency:

A factor showing the degree of completeness with which a cylinder is charged, exhausted and recharged as the operating cycle is performed; it is a measure of the adequacy of valves, ports, induction and exhaust systems, etc.

CATALOGUE INFORMATION

The catalogues issued by reputable car makers are intended not only to show the vehicle in as attractive a light as possible, but also to provide the prospective buyer with the information he needs, in order for him to decide whether the mechanical characteristics are commensurate with his kind of motoring. Manufacturers however are by no means unanimous as regards their methods of obtaining performance data, and this has to be borne in mind when making comparison as between different models in a similar class.

Engine output:

Engine output, given as maximum brake horse-power at a specified rate of rev/min, is obtained by coupling the engine to a power-absorbing dynamometer on a test-bed. There are two official standards by which this power is judged, these being known as SAE and DIN. The former initials denote the Society of Automotive Engineers whose headquarters are in New York, while the latter stand for Deutsche Industrie Normale. SAE outputs are obtained with accessories such as the fan water pump and generator disconnected, all of which in practice absorb a certain amount of power. The air-filter can also be removed, while the test-house exhaust system may be more conducive to power than that installed in the car. Manual ignition timing and an adjustable carburettor jet are permitted, enabling optimum settings to be made for each point at which power and torque readings are taken.

The DIN standard requires the engine to be tested precisely as installed in the car, with all accessories driven, carburation and ignition as standard with no additions, and the normal manifolding and exhaust system in use. The air intake temperature is also specified as 20 deg C.

The SAE rating has a decided 'sales' advantage, as it may be anything up to 20 per cent higher than the DIN figure; but obviously it bears little relationship to the power produced in service. It is commonly used in the USA and Canada, and in some Eastern countries. DIN standards are employed throughout the European Continent. British makers usually quote the figures as either Gross or Nett. The former can be regarded as equivalent to the SAE rating, and is accordingly exaggerated. The Nett value however is not necessarily the same as the DIN, but in practice, appears to come somewhere between the two extremes at the discretion of individual manufacturers.

Apart from the foregoing, it should also be noted that there is a minor difference between the equivalent British and Continental figures, as the latter equate 735 Watts with 1 hp instead of the British 746 W. Thus 1 hp is equal to 1.014 metric hp.

Torque and brake mean pressure

The figures given for maximum torque can be related to the acceleration and hill-climbing power of the car by taking in the laden weight and gear ratios. However, this requires a fairly expert appraisal, and it generally suffices to note the engine rev/min at which maximum torque and maximum bhp occur. If the former is obtained

at a low engine speed, in comparison with the speed for maximum bhp, the engine will have been designed in general to pull strongly from fairly low speeds. This characteristic is useful in cars which are liable to be heavily laden or used for towing caravans and trailers. The maximum horse-power, however, will be limited in comparison with engines on which maximum torque occurs higher up the speed range. The latter condition indicates that the engine is built for brisk revving and free use of the gearbox, in which case a high performance is obtained. In general, engine design tends towards this type nowadays.

Compression ratio :

There has been a great improvement of late both in the quality of fuel and the variety available. Designers have

taken advantage of these developments, which enable the compression ratio to be increased with a consequent increase in the thermal efficiency of the engine. Higher torque is also obtained, so long as the compression ratio is not increased beyond the maximum advised for any particular fuel grading. It is the rule nowadays for the car maker to specify the fuel to be used, particularly where alternative compression ratios are offered. In such cases, the lower ratio is usually intended for buyers who have to use the vehicle in countries where lower-grade fuel only is obtainable. For environments where motoring is well established, however, compression ratios of between 8 and 9:1 are quite normal on family-type saloons, while high-powered sports car engines may run on ratios from 10 to 12:1, when using the highest grades available.

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Javelin PC 1950-1951	..	..	..	..	Mitchell	Jowett Javelin Jupiter 1947-53 Autobook
Javelin PD 1951-1952	..	..	..	..	Mitchell	Jowett Javelin Jupiter 1947-53 Autobook
Javelin PE 1952-1953	..	..	..	..	Mitchell	Jowett Javelin Jupiter 1947-53 Autobook
Jupiter Mk 1 SA 1949-1952	..	..	..	..	Mitchell	Jowett Javelin Jupiter 1947-53 Autobook
Jupiter Mk 1A SC 1952-1953	..	..	..	..	Mitchell	Jowett Javelin Jupiter 1947-53 Autobook
MG						
TA 1936-1939	..	..	..	..	Ball	MG TA-TF 1936-55 Autobook
TB 1939	..	..	..	..	Ball	MG TA-TF 1936-55 Autobook
TC 1945-1949	..	..	..	..	Ball	MG TA-TF 1936-55 Autobook
TD 1950-1953	..	..	..	..	Ball	MG TA-TF 1936-55 Autobook
TF 1952-1954	..	..	..	..	Ball	MG TA-TF 1936-55 Autobook
TF 1500 1954-1955	..	..	..	..	Ball	MG TA-TF 1936-55 Autobook
Midget 1961-1969	..	..	..	..	Ball	Sprite, Midget Autobook
Magnette ZA, ZB 1955-1959	..	..	..	..	Ball	BMC Autobook Three
Magnette 3, 4 1959-1968	..	..	..	..	Smith	BMC Autobook One
MGA 1500, 1600 1955-1962	..	..	..	..	Ball	MGA, MGB 1955-69 Autobook
MGA Twin Cam 1958-1960	..	..	..	..	Ball	MGA, MGB 1955-69 Autobook
MGB 1962-1969	..	..	..	..	Ball	MGA, MGB 1955-69 Autobook
1100 1962-1968	..	..	..	..	Ball	1100, 1300 Autobook
1300 1967-1969	..	..	..	..	Ball	1100, 1300 Autobook
MORGAN						
Four-wheelers 1936-1968	..	..	..	..	Clarke	Morgan Autobook One
MORRIS						
Oxford 2, 3 1956-1959	..	..	..	..	Ball	BMC Autobook Three
Oxford 5, 6 1959-1969	..	..	..	..	Smith	BMC Autobook One
Minor series 2 1952-1956	..	..	..	..	Ball	Morris Minor Autobook
Minor 1000 1957-1969	..	..	..	..	Ball	Morris Minor Autobook
Mini, Cooper, Cooper S 1959-1969	..	..	..	..	Ball	Mini Autobook
1100 1962-1969	..	..	..	..	Ball	1100, 1300 Autobook
1300 1967-1969	..	..	..	..	Ball	1100, 1300 Autobook
1800 Mk 1 1966-1968	..	..	..	..	Ball	1800 Autobook
1800 Mk 2 1968-1969	..	..	..	..	Ball	1800 Autobook
RILEY						
1.5 1957-1965	..	..	..	..	Ball	BMC Autobook Three
4/68 1959-1961	..	..	..	..	Smith	BMC Autobook One
4/72 1961-1969	..	..	..	..	Smith	BMC Autobook One
Elf 1961-1966	..	..	..	..	Ball	Mini Autobook
1100 1965-1968	..	..	..	..	Ball	1100, 1300 Autobook
1300 1967-1969	..	..	..	..	Ball	1100, 1300 Autobook
ROVER						
60 1953-1959	..	..	..	..	Ball	Rover 60-110 1953-64 Autobook
75 1954-1959	..	..	..	..	Ball	Rover 60-110 1953-64 Autobook
80 1959-1962	..	..	..	..	Ball	Rover 60-110 1953-64 Autobook
90 1954-1959	..	..	..	..	Ball	Rover 60-110 1953-64 Autobook
95 1962-1964	..	..	..	..	Ball	Rover 60-110 1953-64 Autobook
100 1959-1962	..	..	..	..	Ball	Rover 60-110 1953-64 Autobook

<i>Make</i>	<i>Author</i>	<i>Title</i>
105R 1957-1958	Ball	Rover 60-110 1953-64 Autobook
105S 1957-1959	Ball	Rover 60-110 1953-64 Autobook
110 1962-1964	Ball	Rover 60-110 1953-64 Autobook
2000 SC 1963-1969	Ball	Rover 2000 1963-69 Autobook
2000 TC 1963-1969	Ball	Rover 2000 1963-69 Autobook
3 litre Saloon Mk 1, 1A 1958-1962	Ball	Rover 3 litre 1958-67 Autobook
3 litre Saloon Mk 2, 3 1962-1967	Ball	Rover 3 litre 1958-67 Autobook
3 litre Coupé 1965-1967	Ball	Rover 3 litre 1958-67 Autobook
SINGER		
Chamois 1964-1969	Smith	Hillman Imp 1963-69 Autobook
Chamois Sport 1964-1969	Smith	Hillman Imp 1963-69 Autobook
Gazelle series 6 1965-1967	Ball	Hillman Minx 1965-67 Autobook
Vogue series 4 1965-1967	Ball	Hillman Minx 1965-67 Autobook
Vogue 1725 1966-1969	Smith	Hillman Hunter 1966-69 Autobook
SKODA		
440, 445, 450 1957-1969	Skoda	Skoda Autobook One
SUNBEAM		
Alpine series 1 1959-1960	Ball	Sunbeam Rapier Alpine 1959-65 Autobook
Alpine series 2 1960-1963	Ball	Sunbeam Rapier Alpine 1959-65 Autobook
Alpine series 3 1963-1964	Ball	Sunbeam Rapier Alpine 1959-65 Autobook
Alpine series 4 1964-1965	Ball	Sunbeam Rapier Alpine 1959-65 Autobook
Alpine series 5 1965-1967	Ball	Hillman Minx 1965-67 Autobook
Rapier series 3 1959-1961	Ball	Sunbeam Rapier Alpine 1959-65 Autobook
Rapier series 3A 1961-1964	Ball	Sunbeam Rapier Alpine 1959-65 Autobook
Rapier Series 4 1963-1965	Ball	Sunbeam Rapier Alpine 1959-65 Autobook
Rapier Series 5 1965-1967	Ball	Hillman Minx 1965-67 Autobook
Imp Sport 1963-1969	Smith	Hillman Imp 1963-69 Autobook
Stilletto 1967-1969	Smith	Hillman Imp 1963-69 Autobook
Rapier 1725, H120 1725 1967-1969	Smith	Hillman Hunter 1966-69 Autobook
TRIUMPH		
Herald 948 1959-1964	Smith	Triumph Herald 1959-69 Autobook
Herald 1200 1961-1967	Smith	Triumph Herald 1959-69 Autobook
Herald 12/50 1963-1967	Smith	Triumph Herald 1959-69 Autobook
Herald 13/60 1967-1969	Smith	Triumph Herald 1959-69 Autobook
Spitfire 1962-1969	Smith	Triumph Spitfire Vitesse 1962-69 Autobook
Vitesse 1600 and 2 litre 1962-1969	Smith	Triumph Spitfire Vitesse 1962-69 Autobook
GT Six 2 litre 1966-1969	Smith	Triumph Spitfire Vitesse 1962-69 Autobook
VANDEN PLAS		
3 litre 1959-1964	Ball	BMC Autobook Four
1100 1963-1968	Ball	1100, 1300 Autobook
1300 1967-1969	Ball	1100, 1300 Autobook
VAUXHALL		
Victor 1 1957-1959	Ball	Vauxhall Victor 1, 2, FB 1957-64 Autobook
Victor 2 1959-1961	Ball	Vauxhall Victor 1, 2, FB 1957-64 Autobook
Victor FB 1961-1964	Ball	Vauxhall Victor 1, 2, FB 1957-64 Autobook
VX4/90 FBH 1961-1964	Ball	Vauxhall Victor 1, 2, FB 1957-64 Autobook
Victor FC 101 1964-1967	Ball	Vauxhall Victor 101 1964-67 Autobook
VX 4/90 FCH 1964-1967	Ball	Vauxhall Victor 101 1964-67 Autobook
Velox, Cresta PA 1957-1962	Ball	Vauxhall Velox Cresta 1957-69 Autobook
Velox, Cresta PB 1962-1965	Ball	Vauxhall Velox Cresta 1957-69 Autobook
Cresta PC 1965-1968	Ball	Vauxhall Velox Cresta 1957-69 Autobook
Viscount 1966-1969	Ball	Vauxhall Velox Cresta 1957-69 Autobook
Viva HA (inc. 90) 1964-1966	Ball	Vauxhall Vica HA 1964-66 Autobook
Viva HB (inc. 90 and SL90) 1966-1969	Ball	Vauxhall Viva HB 1966-69 Autobook
Victor FD 1599 cc 1967-1969	Ball	Vauxhall Victor FD 1600, 2000 1967-69 Autobook
Victor FD 1975 cc 1967-1969	Ball	Vauxhall Victor FD 1600, 2000 1967-69 Autobook

VOLKSWAGEN

1200 Beetle 1954–1966	Ball	Volkswagen Beetle 1954–67 Autobook
1200 Karmann Ghia 1955–1965	Ball	Volkswagen Beetle 1954–67 Autobook
1200 Transporter 1954–1964	Ball	Volkswagen Beetle 1954–67 Autobook
1300 Beetle 1965–1967	Ball	Volkswagen Beetle 1954–67 Autobook
1300 Karmann Ghia 1965–1966	Ball	Volkswagen Beetle 1954–67 Autobook
1500 Beetle 1966–1967	Ball	Volkswagen Beetle 1954–67 Autobook
1500 Karmann Ghia 1966–1967	Ball	Volkswagen Beetle 1954–67 Autobook
1500 Transporter 1963–1967	Ball	Volkswagen Beetle 1954–67 Autobook

WOLSELEY

1500 1959–1965	Ball	BMC Autobook Three
15/50 1956/1958	Ball	BMC Autobook Three
15/60 1958–1961	Smith	BMC Autobook One
16/60 1961–1969	Smith	BMC Autobook One
6/99 1959–1961	Ball	BMC Autobook Four
6/110 1961–1968	Ball	BMC Autobook Four
Hornet 1961–1966	Ball	Mini Autobook
1100 1965–1968	Ball	1100, 1300 Autobook
1300 1967–1969	Ball	1100, 1300 Autobook

